THURSDAY, FEBRUARY 12, 1920.

ASSET AND OBLIGATION.

WE referred in our issue of January 29 to an appeal made by University College, London, for 100,000*l.* for the extension of its engineering school. The work done there since its foundation in 1828 has been of such outstanding value that it should stimulate a ready response in the form of generous subscriptions to the amount required for the desired extension. The need is now very urgent, as the college, like others, has been compelled to refuse a large number of applications for admission by well-qualified candidates owing to lack of accommodation in the lecture rooms, drawing offices, and laboratories.

University College was the first in London to establish a school of engineering, soon after its foundation in 1826, and it has maintained its courses of study in this branch of applied science ever since as a potent and living force. It has always had the advantage of the guidance of distinguished engineers for its teaching, and they have greatly assisted the advancement of engineering by their inventions and contributions to applied science, as well as by their distinction in practical engineering affairs. Among these in its early days were three Fellows of the Royal Society—Eaton Hodgkinson, a great authority on the strength and testing of materials, notably in connection with columns, and C. B. Vignoles, also widely known on questions relating to railways, while William Pole exercised a great influence on contemporary engineering as secretary of the Institution of Civil Engineers. Other distinguished men of a somewhat later period are George Fuller, the inventor of a well-known form of slide-rule, and the eminent electrician, Fleeming-Jenkin, who for a short period was professor of civil engineering.

The advent of Prof. A. B. W. Kennedy (now emeritus professor) in 1874 marked a new epoch in its influence on contemporary thought in engineering science, since it was mainly due to his efforts that engineering laboratory training on a practical scale was initiated, and this has now become universal. Besides this notable achievement, Prof. Kennedy's activities during his fourteen years as professor there were remarkable for their extent and variety; he was famed alike for his work as an original investigator in such matters as riveted joints, marine engines, boilers, and kinematical science, and as an authority on a wide range of civil engineering practice, and still later as one of the foremost electrical engineers of his time. The keynote to his success as a teacher was mainly derived from his clear exposition of principles and their application in well-devised experiments in the laboratory. The effect of his teaching may be traced in the successful careers of his many students, of whom perhaps the best known are Sir Ernest Moir, Bart., a leading authority on harbours and tunnels, and Sir Alexander Gibb, whose firm is responsible for the construction of H.M. Dockyard at Rosyth. Municipal engineering, under the fostering care of the late Prof. Osbert Chadwick, has now become an important department. In the field of electrical science Dr. J. A. Fleming, the present professor of electrical engineering, has, for more than thirty years, had a far-reaching influence, not only by his great gifts as a teacher, but also as an investigator of rare capacity, particularly on alternating currents and on wireless telegraphy and telephony. Especially important are the services which Dr. Fleming has rendered to telephony by the invention of the thermionic valve, but these are too well known to need recapitulation to scientific readers.

The engineering school at University College is an element, and an important one, in the University of London, the largest university of the Empire, in the richest city, and probably the least well off when its size is taken into consideration. In University College alone there are more than 2200 students, without taking into account the medical students in University College Hospital. There will be many more if its buildings can be enlarged, as they must be if the University is to do its proper work.

During the war the staff and buildings of the college, like those of similar institutions, were utilised to their fullest extent in scientific work of the highest importance to the effective prosecution of the conflict, and now that it has come to a successful conclusion the men who guide public opinion are unanimous in declaring that one of the most important duties is to provide our universities with adequate means for the scientific training of our most precious asset, "brains," for the future guiding and directing of one of our greatest industries. Civic pride in the University will, we hope and believe, be sufficient to ensure that the engineering students of University College do not lack the modest range of buildings and equipment required to give them their chance in life,

and for which its engineering committee now confidently appeals to the citizens of London to provide.

A very good start has been made by a contribution of 10,000*l.* from Lord Cowdray, with a promise of another 10,000*l.* when 70,000*l.* has been reached. The members of the family of the late Mr. Charles Hawksley have contributed 3000*l.* towards the extension of the hydraulic laboratory. Other gifts bring the total up to about 30,000*l.*, apart from Lord Cowdray's contingent promise. London is now offered an excellent opportunity of showing its appreciation of the asset it possesses in the engineering department of the college, and of discharging its obligations to an essential factor of modern progress. We look to men of means in the City and county of London to respond readily and generously to the appeal. Donations should be sent to H.R.H. Prince Arthur of Connaught, who is president of the Equipment and Endowment Fund, at his residence, 42 Upper Grosvenor Street, W.1.

INDUSTRIAL CHEMISTRY.

(1) *Industrial Gases.* By Dr. Harold Cecil Greenwood. (Industrial Chemistry.) Pp. xvii+371. (London: Baillière, Tindall, and Cox, 1920.) Price 12*s.* 6*d.* net.

(2) *The Condensed Chemical Dictionary: A Reference Volume for all requiring Quick Access to a Large Amount of Essential Data regarding Chemicals and other Substances used in Manufacturing and Laboratory Work.* Compiled and edited by the editorial staff of the Chemical Engineering Catalog. Pp. 525. (New York: The Chemical Catalog Co., Inc., 1919.) Price 5 dollars.

(1) A MELANCHOLY interest attaches to this book, which of itself would disarm any adverse criticism, even if such were called for. Its author, a comparatively young man, died on the eve of its publication. After a brilliant career at the University of Manchester, of which he was a Beyer Fellow, and where he graduated as a Doctor of Science, Dr. Greenwood worked as an 1851 Exhibition scholar for some years under Prof. Haber at Karlsruhe on the synthetic production of ammonia. During the war he became connected with the research laboratory of the Ministry of Munitions, and was engaged in the inquiry initiated by the Munitions Inventions Department on the industrial manufacture of synthetic nitrogen products. His services were recognised by the O.B.E. awarded to him in 1919. In a foreword to the book, Dr. J. A. Harker, under whom the author served, pays a graceful tribute to his memory.

Dr. Greenwood's published work and experience rendered him exceptionally well qualified to undertake the preparation of the book under review. We can unreservedly commend it. It is a well-written, scholarly production, judiciously put together with a conscientious determination to make it an accurate presentation of contemporary knowledge. As the author points out in his preface, its title implies a more comprehensive treatise than it actually is; many industrial gases, such as chlorine, hydrochloric acid, ammonia, acetylene, etc., find no place in it, as these are treated in other books in the same series. He confines himself to the gases of the atmosphere, hydrogen, the oxides of carbon, sulphur dioxide, nitrous oxide, and certain substances which have been used in gas-warfare, and he devotes a special section to fuel gases, on account, as he states, of the intimate connection of their methods of production with the general question of industrial gases.

The main subject of the book is introduced in a chapter on the more important fundamental physical and physico-chemical principles forming the basis of technical gas reactions, although no attempt is made to give a detailed theoretical treatment of the various generalisations to which reference is necessarily made. In this chapter the gases in general are treated comprehensively, and the numerical values of their various constants are grouped together in a series of tables. This method, no doubt, has certain advantages, as it enables rapid comparison to be made between individual gases, but when we come to their detailed study it involves a good deal of turning backwards and forwards. It would have added little to the size of the book, and would certainly have increased the convenience of handling it, if the various constants and factors had been repeated in the special accounts of the several gases. The author would seem to have been primarily concerned with the general principles of gas technology and their elucidation rather than with the minute treatment of individual gases. As might be expected from his experience, which had been latterly almost wholly directed to problems arising out of the war, such questions as the manufacture of hydrogen for aeronautical purposes and for the synthetic production of ammonia naturally receive special attention. Naturally also, he devotes much consideration to the question of gaseous equilibria and to that of heterogeneous catalytic gas reactions, without doubt among the most important matters in modern chemical technology. The entire chapter is worthy of the serious study of all engaged in the technical production of gases and in the

working of processes depending upon their reactions. The superintendence of such processes is frequently left wholly to the engineer, who is often imperfectly acquainted with the physico-chemical principles on which they are based. Modern methods involving thermodynamical and thermochemical principles are becoming of so complex a character that their satisfactory working can be assured only when they are under the joint control and co-operation of both chemists and engineers.

A chemist, like the present writer, whose memory goes back some fifty years, will read this book with a special interest, and, if his scientific imagination is not dulled with age, he will experience a grateful sense of satisfaction that he has lived to see the extraordinary development it records. The whole story, indeed, reads like a romance; even Jules Verne in his wildest flights never imagined anything so astonishing as is revealed in this sober, matter-of-fact account which Dr. Greenwood has put together. Compare, for instance, the non-metallic section of an early or even of a late edition of Miller's "Inorganic Chemistry"—an excellent book in its day—with the present volume. One thus acquires an impression almost startling in its intensity of the changes which the last half-century has witnessed, even in matters of which the scientific history seems completed. The liquefaction of the so-called permanent gases; the industrial application of the Joule-Thomson effect; the manufacture of liquid air, its commercial application, and the fractional separation of its constituents; the discovery of argon and its allies—no longer the "tramps" of the chemical elements "who never did an honest day's work in their lives," but now turned to useful account—the isolation of terrestrial helium, its manufacture, and its use in aeronautics; the direct transformation of the "inert" nitrogen into products which serve to increase the food of man, and thus stave off the catastrophe which the late Sir William Crookes foreshadowed; the application of hydrogen in the production of fats: all this and more is set forth with the precision, impartiality, and unimpassioned detail of the man of science—"the matter of fact being barely stated without any prefaces, apologies, or rhetorical flourishes," to quote the words of the old statute of the Royal Society.

One closes this book with profound regret that its author's untimely death should have ended a career so full of promise.

(2) "The Condensed Chemical Dictionary," published by the Chemical Catalog Co., of New York, is a characteristic American production. To parody Thackeray's well-known phrase, it is written—or, rather, compiled—by hustlers for hustlers. It is one of those books which "Elia" would have stigmatised as "no book." It has no valid claim to be regarded as a contribution to chemical technology. It is apparently intended for the office-desk of the wholesale distributor or forwarding agent of chemical products who may wish to know something—but not too much—of the nature of the substances with which he deals; how they are made; what are their "grades" and uses; how they should be packed; what is their "fire hazard"; and what regulations the shipping and railroad companies impose on their transit. It makes ample allowance for the ignorance of clients, and does everything possible to facilitate business. Should further information be needed it is suggested that reference should be made to other works of a similar character published by the "Catalog Company."

The plan of the Dictionary may best be illustrated by an example:—

"ACETAMIDE * (acetic acid amine), CH_3CONH_2.
Color and properties: Colorless crystals; mousy odor.
Constants: Specific gravity, 1·139; melting-point, 82° C.; boiling-point, 223° C.
Soluble in water and alcohol.
Derivation: By the interaction of ethyl acetate and ammonium hydroxide.
Method of purification: Crystallisation.
Grades: Technical.
Containers: Wooden barrels.
Uses: Organic synthesis.
Fire hazard: None.
Railroad shipping regulations: None."

The asterisk signifies that the substance is made in America.

All the entries, together occupying more than 500 pages of a large octavo volume, are arranged in this manner. The cast-iron uniformity of the plan imposed upon the compilers occasionally gets them into trouble. Thus in the case of fluorine, which the Dictionary informs us is manufactured in the States for organic synthesis, no practical container has been devised, as all ordinary substances are attacked by it. Nevertheless, a green label is directed to be attached to the vessel which holds it should it be sent by rail.

Standard works have been consulted in the compilation, and care appears to have been used in the selection of recent and accurate numerical data. A number of useful tables are given in an appendix, together with a list of definitions of physical and other units in common use, and the whole concludes with a statement of the regulations governing the transportation of dangerous articles, other than explosives, by freight and express.

THE ORIGIN OF PLANT LIFE ON LAND. Thalassiophyta and the Subaerial Transmigration. By A. H. Church. (Botanical Memoirs, No. 3.) Pp. 95. (London: Oxford University Press, 1919.) Price 3*s*. 6*d*. net.

MR. CHURCH has produced a very serious contribution to the discussion of the sources of plant life on land. No one interested in this question can neglect his work. The statement is attributed to Weismann that the birthplace of all animal and plant life lies in the sea. Mr. Church circumscribes that thesis in his opening words, "The beginnings of botany are in the sea"; and his essay has as its object to demonstrate that the land flora originated, as the primal land-surfaces rose gradually above the ocean, from a marine flora already fixed upon its shores. He designates as "Thalassiophyta" the whole of the salt-water vegetation, and as "Xerophyta" the whole of the land flora. The former he divides again into Plankton and Benthos, pointing out that Plankton responds to the single factor of water, Benthos to the two factors of water and substratum, while Xerophyton responds to the three factors of water, substratum, and air. His main thesis is that the last was derived from the higher types of Benthos. "Processes of conduction and absorption involving roots and tracheides are initiated, and such departures superimposed on a seaweed soma." "The tetraspores of the sea become 'homosporous,' air-dried, and wind-borne" (p. 44).

Thus the evolution of a land flora was a phase of transition *in situ* rather than involving a preliminary landward migration, *via* fresh water. The successful transmigrant algæ of the first land migration combined the best and highest factors of marine equipment, as illustrated in many surviving groups. At the outset Mr. Church separates the problem of this migration from the origin of a cytological cycle, maintaining that the latter was already established before the migration took place. For these conclusions argument is produced rather than fact; indeed, there appears to be no new body of fact in the whole memoir. The author remarks incidentally that homoplasy and convergence have been much neglected. We agree; but may not they explain much of what he interprets as evidence of a direct migration?

Two serious omissions appear in the memoir. There is no reference to the important discoveries of Lower Devonian fossils in the Rhynie Chert, though the description of Rhynia was published early in 1917. Kidston and Lang give positive fact as to the structure of one of the earliest known land-plants; and secure fact is worth a vast amount of surmise and argument. Nor does Mr. Church refer to the question of transference of the tetrad-division in the course of descent to a fresh position in the life-cycle, though Svedelius had raised that question in 1916, and adduced facts very pertinent to it. Such facts, and the arguments that may be based upon them, might, if they had been taken into account, have materially affected Mr. Church's statements.

Notwithstanding such omissions, the memoir is a real contribution to morphological thought. It may be that Mr. Church has over-accentuated the directness of the origin of land-plants from marine forms. But he has carefully protected himself by saying that "no Phæophycean or Floridean passed on to higher autotrophic land-flora" (p. 42). The cautious philosopher, while sympathising with Mr. Church's general thesis, would probably prefer to give greater elasticity to it, seeing in the modern marine flora suggestions upon which to base hypotheses rather than those blunt statements of conclusion which find their place in Mr. Church's pages. However that may be, the effect of "Thalassiophyta" will be to direct attention, which was already swinging that way, more definitely towards marine rather than to fresh-water algæ, as a probable source of land vegetation. Though some of Mr. Church's conclusions may not find wide acceptance, the memoir is the most thoughtful contribution to the question in recent years, and it is full of originality and of interesting though bluff criticisms. F. O. B.

NORMAL AND MORBID PSYCHOLOGY. Mind and its Disorders: A Text-book for Students and Practitioners of Medicine. By Dr. W. H. B. Stoddart. Third edition. (Lewis's Practical Series.) Pp. xx + 580. (London: H. K. Lewis and Co., Ltd., 1919.) Price 18*s*. net.

A REVIEW of the new edition of this well-known text-book is justified by extensive modifications corresponding to the author's conversion to the doctrines of Freud. The volume contains in 572 pages an account of normal and morbid psychology—including the tracing of all mental processes in psychological terms to their original elements and their correlation with their neural equivalents—of the clinical forms of all the neuroses and psychoses and their investigation and treatment, of the diseases to which the insane are specially liable, and of the legal relations of insanity.

Most modern problems in all these subjects are touched upon, and the book provides the sort of knowledge required by the student and general practitioner and a starting point from which the

serious study of one of these branches might be begun.

Necessarily the accounts given are summary, and perhaps dogmatism is also necessary, but some of the matter included might give way to at least a brief statement of the other side of the case. The enunciation of the James-Lange theory of emotion at the present day without reference to any opposition except a footnote controverting deductions from Sherrington's dog is somewhat misleading.

A similar lack of proportion in what is intended to be a text-book is noticeable throughout. Undue prominence is given to observations and theories in which the author is specially interested, but which are by no means universally accepted. As a single example, three pages are devoted to the enumeration of many specific tendencies and actions as separate instincts, some of which it would be very difficult to bring within any modern definition of instinct known to the present writer. On the other hand, there is no reference to McDougall's grouping of such actions under a limited number of heads as instincts with associated emotions. The usefulness of the latter concept is sufficiently widely recognised to deserve mention.

Dr. Stoddart, in his adherence to the doctrine of Freud, shows all the devoutness of the convert. He accepts the literal truth of the whole gospel, including such generalisations as that dreams are invariably distorted wish fulfilments, and that neuroses and psychoses are without exception the results of repression of sexual impulses.

Surely the battle dreams of the war neuroses have rendered the former statement untenable except by the exercise of the most perverse ingenuity. As to the second, the employment of the usual evasion that Freud and his followers use the term "sexual" in a much wider sense than is usual renders discussion meaningless. The sexual instinct is not a phenomenal reality, but a concept; the extent to which it is useful to group observed phenomena of conduct under the term is a question, not of fact, but of opinion. However, in practice Dr. Stoddart, like other extreme exponents, refers all abnormalities of thought and conduct to the crudest anomalies of this instinct in its narrowest sense.

The reviewer accepts most of Freud's description of the manner in which thinking is distorted by "complexes" in the normal and the neuropath, in dreams and similar states. But he failed to repress a smile on comparing two statements in this book, first, that in psycho-analysis suggestion is most scrupulously avoided, and secondly, that with sufferers from anxiety neurosis, terrified by an air raid, the most superficial analysis—presumably to elicit the meaning of the terror—revealed the phallic significance in their minds of Zeppelins, aeroplanes, and bombs! It is the ill-concealed satisfaction of the psycho-analyst with this type of association that evokes them.

The description of the clinical forms of the neuroses and psychoses is excellent apart from a few examples of the disproportion and excessive dogmatism referred to. But with the author's change of views it requires more careful revision to render it consistent.

ASPECTS OF MODERN SCIENCE.

The Realities of Modern Science: An Introduction for the General Reader. By John Mills. Pp. xi+327. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 10*s.* 6*d.* net.

Modern Science and Materialism. By Hugh Elliot. Pp. vii+211. (London: Longmans, Green, and Co., 1919.) Price 7*s.* 6*d.* net.

(1) THE first of these works is evidently that of an enthusiastic scientific student, rather than teacher, who has found the systems of school and college instruction in physical science prevailing in America unsatisfactory. He desires, commendably enough, to see them replaced by courses based fundamentally upon the modern conceptions which have been arrived at only within the last two or three generations, not only for the few specialist, but also for general, students. This praiseworthy motive is, however, not likely to be much furthered by the book under notice. The author would have done better to write a book for science teachers and to assume throughout a knowledge equal to that obtainable from the despised college courses. As it is, it is difficult to understand for whom exactly the book is intended. In the first half the reader is assumed to be the veriest tyro in science, and there is much gilding of the philosophic pill. The beginnings of knowledge, of machinery, and of experimentation, weights and measures, the molecular theory, the "realities of science," electrons, the nucleus and energy are discussed rather desultorily. Then follow three chapters on the most obvious and elementary algebra, to which the non-mathematical reader is advised to give only cursory and mechanical reading in order to reach the second part of the book.

Then the author lets himself go. The reader is absolutely forgotten, or at least he must have had, in an interim, the advantage of several years of serious study of science sufficient to enable him to understand, if not to profit by, the particular parts of the last half-century's advances in physics,

physical chemistry, and chemistry which the author reconstructs in terms of the present day. The kinetic theory of gases, the conduction of electricity through gases, liquids, and solids, the phenomena of electromagnetism, the van der Waals equation, solutions, electrolytic dissociation, chemical equilibria and their displacement, le Chatelier's theorem, Brownian movement, electronic and molecular magnitudes, with something about X-rays and radio-active substances, are the subjects which the tyro, who may not be able to comprehend an algebraic relation, is asked to assimilate in the remaining 150 pages. The aid of the merely verbal acquaintance he has made with the few ultimate conceptions of physics is not likely to fit him for the task. For these conceptions—matter, energy, radiation, the electron, the nucleus, the quantum, and so on—are the end-products of scientific philosophy, not the starting points, and cannot replace, at all events yet, the body of experimental and actual scientific knowledge out of which they have grown. It is true that they may be the "realities of modern science," but a universe reconstructed out of them *ab initio* without other guide would bear as little resemblance to reality as that created by the end-products of mythological and religious philosophy.

(2) This work is of a totally different character, and though it represents the same desire to synthesise and bring within the comprehension of the individual a vast range—in fact, in this case, the whole—of knowledge by means of a few generalised conceptions, it is written and intended for the serious student and mature thinker. The author upholds the extremest doctrines of materialistic philosophy. To him there is no real distinction between an engine and an engine-driver. In such philosophical discussions it is well to remember the mathematical adage that what is got out in the proof is no more and no less than what was put in at the enunciation. The first two chapters, on the (inanimate) universe and on matter and energy, give an excellent account of scientific materialism, as now universally accepted for the inanimate world. The rest of the book, on life and consciousness, on the fallacy of vitalism, and on materialism and idealism, seeks to extend this doctrine of the inanimate universe to the animate, with results as outrageous to common sense surely as any philosophical system ever devised.

The main, if not the only, issue of scientific interest, the difference between a complex organic compound and a living organism, or, for that matter, between the same organism alive and dead, is ignored. Living protoplasm is just a complex organic compound, so very complex that it nourishes itself by internal secretion, reproduces itself, and, gradually, throughout geological time modifies itself in constitution, so that, originally an amœba, it finishes as a man. To the chemist, who may be supposed to know something at least about chemical compounds, if not to the biologist, the view that living protoplasm is no more than a very complex compound is fantastic.

Laplace's doctrine of rigid determinism, applied to this monism of the animate and inanimate, leads the author to deduce that what he is now writing and the sentiments his words will convey to his readers could have been known and predicted a myriad years ago by a being of infinite knowledge and mathematical power from a study of the distribution of matter and energy in the original nebula. Events of great consequence to the future are frequently decided by men on the spin of a coin. Leave out the inanimate world and whether from his nebula the omniscient being could predict the fall of the coin, though the modern mathematical physicist would probably give reasons for an answer to this question totally different from Laplace's view. Leave out the question of moral judgments, and how they originate, altogether. Here is a man on the point of calling "Heads or Tails?" to decide the course of the future—but with the decision still untaken—with a certain distribution of energy and matter in his brain. We are asked to believe that this matter and energy will be differently distributed in a manner obvious to an omniscient being—that one distribution will make him call "Tails" and another "Heads." A scientific materialism that calmly accepts positive answers to such unsolved problems as these concerning free-will and the nature of life is scientific surely only in name.

F. SODDY.

OUR BOOKSHELF.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College and Papers in Elementary Engineering for Naval Cadetships for the Years 1909–18. Edited by R. M. Milne. (London: Macmillan and Co., Ltd., 1919.) Price 7*s*.

A RECENT issue of this collection of examination papers has been reviewed in NATURE. It remains only to say that the papers added in the new issue maintain the standard of excellence already noticed. The questions are remarkably suitable for the discovery of what the candidates know.

Mesures Pratiques en Radioactivité. By Dr. W. Makower and Dr. H. Geiger. Traduit de l'Anglais by E. Philippi. Pp. vii+181. (Paris: Gauthier-Villars et Cie, 1919.) Price 8 francs.

A GOOD French translation of this well-known and admirable work.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Euclid, Newton, and Einstein.

SINCE the results of the Eclipse Expedition of May last have been made public a very great deal of general interest has been displayed in a theory which, until a few weeks ago, was known only to mathematicians and physicists. Even among these, not many could offer any adequate explanation of the new view of space and time and their mutual relations, while some regarded the whole question as a mathematical joke which led to interesting results of no practical value; and probably not a few thought that a non-Euclidean system of geometry was inadmissible in any physical theory of the universe. On the other hand, there are some who have gone so far as to advocate that non-Euclidean geometry should be taught to boys and girls in secondary schools. The published books on this subject do not come into touch with any ordinary experience, and the whole subject, consequently, has been regarded as a mathematical fiction. So far from this being so, most people have actually seen the ordinary operations of life proceeding in non-Euclidean space, though they have not realised the meaning of all they have seen. In the space behind a plane mirror objects are reversed right and left (perverted), though in all other respects they correspond precisely to the real objects in front of the mirror of which they are the images, but in the space behind a convex mirror this is not the case. The geometry of this space and the behaviour of moving bodies therein, as viewed by the external observer and as studied by an intelligent being within the image space, say, the image of the external observer, who applies to the images and their movements the same standards of measurement as the external observer applies to the real objects in his own space, introduce us to a non-Euclidean space which is the subject of common observation, and prepare the mind for the reception of many of the conclusions of the now famous theory of relativity. In the discussion of that theory two observers are supposed to be moving relatively to one another, each with his own set of measuring instruments and each living in his own world or system, and the differences between the phenomena which occur in each system as measured by the dweller in that system and by the external observer form the basis of the theory. Corresponding to these two observers we propose to consider the actual observer outside the convex mirror and his supposed intelligent image behind the mirror, and to consider how the images behind the mirror, treated as real objects, appear to behave to both observers.

In the first place, it is necessary to consider the size and shape of the objects, or, in other words, the geometry of the space. To save repetition it will be convenient to call the external observer A and his intelligent image B. The line joining the middle point of the mirror with the centre of the sphere of which the surface of the mirror is a part is the axis of the mirror, and may be supposed to be extended indefinitely outside the mirror. The image of an infinitely distant star on the axis of the mirror will be formed at a point half-way between the surface of the mirror and the centre of the sphere. This point is called the principal focus, and its distance from the mirror is the focal length, which is half the radius. It will be convenient to call this point F. A series of lines drawn from the circumference of the mirror outwards and all parallel to the axis encloses a cylindrical space to which the external objects considered are to be confined. All these lines produced indefinitely will at length meet the star on the axis of the mirror. Their images will, therefore, all converge to the principal focus F, and the whole of the infinite cylinder in the external world will correspond to a cone behind the mirror having F for its vertex and the mirror for its curved base. If an object outside moves away to infinity its image will never get beyond F, and the images of straight lines meeting the mirror and extending parallel to the axis as far as the distant star will all meet at F. We shall suppose the radius of curvature of the mirror to be very large as compared with the dimensions of the mirror itself or of the observer.

There is a very simple geometrical law connecting the distance of an object from the mirror and the distance of its image from F. This law need not concern us except to point out that as the object recedes from the mirror its image approaches F, and, as seen by the external observer, the dimensions of the image in all directions at right angles to the axis are proportional to its distance from F, but the dimensions parallel to the axis are proportional to the square of the distance from F of the image. This is the peculiar property of convex mirror space. If a cricket-ball is placed in front of the mirror at a distance equal to the focal length, its image will be half-way between the mirror and F, but the image will not be spherical. In all directions at right angles to the axis the dimensions will be reduced to one-half, but along the axis they will be reduced to one-quarter, so that the sphere will be represented by an oblate spheroid (an orange) with a polar axis one-half of the equatorial diameter. If the ball moves farther from the mirror the oblateness of the spheroid will be increased, and when the image is three-quarters of the way between the mirror and F the polar axis will be only one-quarter of the equatorial diameter of the spheroid, which will itself be only one-quarter of the diameter of the cricket-ball. If a circular hoop is placed with its plane at right angles to the axis its image will be circular, but if it is turned round so that its plane is parallel to the axis the image will be an ellipse, which will become more and more eccentric as the hoop recedes from the mirror and the image diminishes on approaching F. A top set spinning with its axis perpendicular to the axis of the mirror will appear in its image to the external observer to be elliptic, with its axes fixed in space, so that as any line of particles in the top approach parallelism to the axis of the mirror they will be squeezed together and expand again as they recede from parallelism. Midway between the mirror and F the density of the top will appear to A to be twice as great in the direction of the axis as in any direction at right angles to the axis, for the same number of particles will be squeezed into half the length.

All this has been written from the point of view of A, the external observer. But how will all these things appear to B, who is living and moving in the mirror space? Like A, the observer B may use a foot-rule for measuring length, breadth, and thickness, and a protractor for measuring angles. As A proceeds to measure the real object, B proceeds to measure the image, but as he approaches the focus his foot-rule, like himself and the image he is going to measure, gets smaller and in precisely the same proportion, so that if the image measured 6 in. in height when close to the mirror, it would always appear to measure 6 in. in height, for, as seen by A, the foot-rule would contract just as the image con-

tracted, though B would be unconscious of the contraction. Moreover, half-way between the mirror and the focus B's foot-rule will appear to A to be only 6 in. long when held perpendicular to the axis, but when turned parallel to the axis it will appear to A to be only 3 in. long, and if it is turned round it will contract in exactly the same way as the image which it is used to measure. B, therefore, will be quite unable by means of his foot-rule to ascertain that the cricket-ball is no longer spherical, or the top or hoop no longer circular. The judgment of A and that of B will therefore be entirely discordant.

If a circle divided by radii, say 5° apart, into equal angles is held with its plane perpendicular to the axis, the image will appear to both A and B to be circular and the angles equal, but if it is turned with its plane parallel to the axis the image to A will appear an ellipse and the angles in each quadrant unequal, but B will have no means of detecting these inequalities, and he will place implicit faith in the accuracy of his protractor.

The question will naturally be asked: Cannot B see that his circle has become an ellipse? When the plane of the circle is at right angles to the axis and B looks straight at it, the image on B's retina, as it appears to A as well as to B, is circular, but when the circle is turned round and B turns round to look at it, B's retina undergoes precisely the same changes as the circle itself, and still the image occupies the same portion of B's retina as before, and therefore produces the same mental impression of a circle on B, though A recognises the ellipticity of B's retinal image (which A is supposed to see in the mirror).

If A walks straight away from the mirror to an indefinite distance, B will walk towards the focus, but as A can never reach the star, so B, walking, as he thinks, uniformly, can never reach F. In fact, his speed of walking as seen by A appears to diminish in proportion to the square of his distance from F, as all small distances measured along the axis diminish in this ratio, but B can never discover this, for he always appears to walk the same number of feet in a minute, as measured by his own diminishing foot-rule. It is true that when B's height and the length of his legs appear to A to be reduced to one-half, the length of his step appears to be reduced to one-quarter, and the angle between his legs as he walks to be reduced correspondingly; but if B tries to measure this angle, his protractor suffers the same distortion, as recognised by A, and B thinks he is walking always in precisely the same way.

It appears, then, that to B the principal focus F is infinity. He can never reach it, however long or however quickly he walks; and there is nothing in his world beyond it. All straight lines drawn from F to the mirror appear to B to be parallel, for they meet only at infinity, and he can never reach their point of meeting. They correspond to parallel lines in the Euclidean space outside the mirror. The image of a square held with its plane perpendicular to the axis will appear to both A and B to be square, but, held with two of its sides parallel to the axis, the angles of the square will appear to A to be unequal, for the two sides parallel to the axis will converge to F, and the dimensions of the square along the axis will be less than its dimensions at right angles, but neither the foot-rule nor the protractor in the hands of B will detect these irregularities. In convex mirror space straight lines which meet at F are parallel.

If two of the straight lines which appear to B to be parallel are cut by a third line, and the figure is examined by A, the two interior angles on the same side of the cutting line do not appear to be equal to two right angles, and the exterior angle does not appear to be equal to the interior and opposite angle. This is the essential feature of convex looking-glass space, but B will not agree with A on either question. To B, Euclid's propositions respecting parallel straight lines will appear to hold. He will think that he is living in Euclidean space, though A knows better, or thinks he knows.

To the external observer, then, convex looking-glass space has different properties as the focus is approached, or, in technical phrase, it is not homoloidal, and it has different properties in different directions, like a uniaxial crystal—that is, it is not isotropic, but differs from the crystal since its lack of isotropism increases as the focus is approached. The image of a metre rod nine-tenths of the distance from the mirror to the focus will appear to the external observer to measure a decimetre when at right angles to the axis, but only a centimetre when parallel to the axis.

This "distortion" of space is precisely what happens according to the theory of relativity in the neighbourhood of a gravitating body, though the distortion is very small even at the surface of the sun. In the direction of the gravitation pull space is contracted, and a foot-rule is actually shorter than when it lies at right angles to the force to the extent of about 43 parts in 10,000,000 at the sun's surface. The effect is greater the greater the intensity of gravitation, and, consequently, it increases on approaching a gravitating body.

If space is supposed to be occupied by points, and the length of a line to be measured by the number of points in it, then in space free from gravitation the points are equally distributed in all directions, but when gravity acts the points are closer together in the direction of gravity than in other directions, as soldiers in column are closer together from right to left than from front to rear, or as the images of evenly distributed points in space are more closely packed along the axis of a convex mirror than in other directions. This representation of the effect of gravity is due to Prof. Eddington. Light always goes from one point to another in the shortest possible time. This principle leads to the ordinary laws of reflection and refraction. In passing through space in the presence of gravitation it will take the path which necessitates passing through the smallest number of spatial points, and this means refraction similar to that produced when it passes into a denser medium in which its velocity is reduced. The effect on light in passing near to the sun will be the same as if the sun were surrounded by an atmosphere extending to a distance of many millions of miles, and diminishing in density as the distance from the sun is increased. This will act like a convex lens refracting the light, which will travel more slowly as it approaches the sun. A comet approaching the sun with the velocity of light would, according to the laws of Newton, travel more quickly as it approached, but its orbit would be bent towards the sun as the light is bent, but only to one-half the extent. If light from a star were passing the sun close to its limb, and behaved like a comet under the sun's attraction, it would be deflected about seven-eighths of a second of arc. On the theory of relativity it would be deflected through $1\frac{3}{4}$ seconds. It was this deflection which the Eclipse Expedition set out to measure. The behaviour of comets shows that there is no solar atmosphere to account for the refraction at distances from the sun at which the refraction was observed.

In all that has been said respecting the space behind a convex mirror the size of the mirror is supposed to be very small as compared with its radius of curvature, and the objects and images much smaller still. If a complete spherical mirror is suspended in free space the geometrical images of the stars will be distributed

over a sphere of half the radius of the mirror, and this spherical surface is infinity to all the dwellers in the mirror space. The image of an object which subtends a large angle at the centre of the mirror will be bent. In Fig: 1, *ab*, *cd*, and *ef* are the images of straight

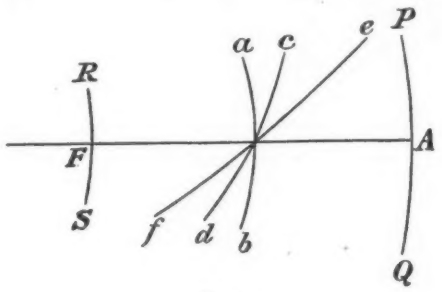

FIG. 1.

lines all passing through the same point distant half the radius from the face of the mirror. These lines are all curved and concave to the centre of the mirror, but they are straight lines in convex mirror space, and pass through the smallest number of spatial points of any line joining the extreme points. They are the paths which would be taken by rays of light in space in which the spatial points were packed as in convex mirror space. In every case the light is refracted towards the portion of space in which the point density is greatest. In the figure PQ represents the mirror, RS the focal sphere of half the radius, while the images correspond to straight lines cutting FA produced in the same point at 90°, 45°, and 22½° respectively. It will be seen that the curvature of *ab* enables it to pass through a region in which the points are less closely packed than along the line joining *a* and *b*, which appears to the external observer to be straight. On the Einstein theory, light passing a gravitating body like the sun is refracted in the same way. In convex mirror space strings stretched between the points *a* and *b*, *c* and *d*, and *e* and *f* would take the forms shown. A person in a hurry and endeavouring to pass through a crowd will make a detour to avoid the more densely packed portions of the crowd.

According to the theory of relativity, motion and force, involving time, change the properties of space. In convex looking-glass space position and direction only are involved, so that the problem is much simpler, while many of the results are very similar.

If the two great mechanical principles of the conservation of momentum and the conservation of energy are applied to the movement of bodies in B's space a consistent system of dynamics can be constructed, and B with his measuring instruments will be quite unable to detect any divergence from Newton's laws of motion. To A, however, the laws will appear very different. For example, a body under the action of no external force moving along the axis of the mirror will move with a velocity varying as the square of its distance from F. This means that the apparent mass will vary inversely as the square of the distance of the body from F, and as the body approaches F the mass appears to increase indefinitely. This corresponds to the increase of mass according to the theory of relativity when the velocity of a body increases, becoming infinite as the velocity of light is approached. According to the theory of relativity, the mass of a body is greater in the direction of its motion than in directions at right angles to its direction of motion. In convex looking-glass space the mass is greater, when measured by the accelerative effect of a force, in the direction of the axis than in directions at right angles to the axis, and greater the nearer the focus. The reason why B cannot detect any of these changes is that all his standard units change in the same way; and, as all physical measurements ultimately reduce themselves to a comparison with standard units, if the units change a corresponding change in the quantity measured cannot be detected. We cannot, for instance, detect the variation in the weight of a body between the equator and the poles by means of standard weights and a pair of scales, though we may detect it by a spring-balance or a pendulum. It is always the looker-on, A, who sees most of the game.

Some thirty or more years ago a little *jeu d'esprit* was written by Dr. Edwin Abbott entitled "Flatland." At the time of its publication it did not attract as much attention as it deserved. Dr. Abbott pictures intelligent beings whose whole experience is confined to a plane, or other space of two dimensions, who have no faculties by which they can become conscious of anything outside that space and no means of moving off the surface on which they live. He then asks the reader, who has consciousness of the third dimension, to imagine a sphere descending upon the plane of Flatland and passing through it. How will the inhabitants regard this phenomenon? They will not see the approaching sphere and will have no conception of its solidity. They will only be conscious of the circle in which it cuts their plane. This circle, at first a point, will gradually increase in diameter, driving the inhabitants of Flatland outwards from its circumference, and this will go on until half the sphere has passed through the plane, when the circle will gradually contract to a point and then vanish, leaving the Flatlanders in undisturbed possession of their country (supposing the wound in the plane to have healed). Their experience will be that of a circular obstacle gradually expanding or growing, and then contracting, and they will attribute to *growth in time* what the external observer in three dimensions assigns to motion in the third dimension. Transfer this analogy to a movement of the fourth dimension through three-dimensional space. Assume the past and future of the universe to be all depicted in four-dimensional space and visible to any being who has consciousness of the fourth dimension. If there is motion of our three-dimensional space relative to the fourth dimension, all the changes we experience and assign to the flow of time will be due simply to this movement, the whole of the future as well as the past always existing in the fourth dimension.

The theory of relativity requires a fourth dimensional term to be introduced into its dynamical equations. This term involves time and the velocity of light. Generally, the easiest method of expressing algebraically position and motion in three-dimensional space is by reference to three directions mutually at right angles, like the edges of a cube which meet at one corner. These lines may, for example, be drawn through the observer north and south and east and west, like the reference lines on a map, while the third line is up and down. The observer's point of reference is where these three lines meet. In four-dimensional geometry there is a fourth direction at right angles to each of the three. Most of us are unable to form any clear picture of such a direction as a purely geometrical conception. To us the only figure which is at right angles to every straight line drawn through a point O is a sphere, or any number of spheres, having O as centre. As stated above, the fourth co-ordinate involves time and the velocity of light together. Imagine these spheres to be always moving inwards towards O with the velocity of light, and then to expand again from O with the same velocity, and this to take place quite uniformly, how-

ever O may move in relation to other points of observation, so that the centre of the system of contracting and expanding spheres travels with the observer, and each observer has his own system of spheres. The approaching and contracting spheres contain within them the whole future; the receding and expanding spheres contain the past. The present is the passage of a sphere through O, the observer, when that sphere is concentrated on a point. This conception of a fourth dimension is thus not that of a simple spatial dimension like the other three, but, as required in the theory of relativity, it is intimately associated with time and motion, and the observer's experience of it is simply the happening of events with the flux of time. It is very like the Flatlander's conception of the third dimension derived from the invading sphere. It will be noticed that to different observers the impressions of the present are not quite the same. We observe an event in a star. It is present to us. To an observer in the star it happened years ago.

The theory of relativity involves a change in the unit of time, according to the motion of the observer relative to the object observed. This complication did not enter into the consideration of the space behind the convex mirror, so that the dynamical problems in that space were relatively simple. According to the theory of relativity, if the observer is moving with the velocity of light, time remains unchanged. This must have been the case with the Mad Hatter. With him it was always six o'clock, and always tea-time.

W. G.

Thermionic Valves on Aircraft.

IN a paper just published in the Proceedings of the Royal Society (A, vol. xcvi.) Drs. W. H. Eccles and J. H. Vincent give an account of some experiments on the small variations of wave-length introduced when changes are made either in filament temperature or plate voltage of a thermionic valve supplying oscillating energy to a wireless circuit. It may be of interest to readers of NATURE to know how this effect influenced the design of wireless aircraft generators used in the war.

In 1916, when experimenting with continuous-wave telegraphy and telephony from aircraft, I noticed a small outstanding variation of wave-length radiated from an aeroplane, which variation seemed to depend mainly on the speed of flight, and therefore, possibly, on the voltages supplied by the windmill-driven generator.

Following up this clue, I found in the Air Force Laboratory that the changes of wave-length introduced by variations of filament temperature and plate voltage were more considerable than I had thought, especially on short wave-lengths.

It was the knowledge of this fact which led to the inclusion of special regulating devices in the aircraft dynamo circuits, so that the wave-length variation, at the best of times noticeable owing to aerial sway, banking, etc., should be reduced, at any rate, to a minimum. R. WHIDDINGTON.

The University, Leeds, February 5.

Popular Science.

I SHOULD like to be allowed to underline a few remarks that occur in a review entitled "Scientific Biography" in NATURE for January 29. The writer urges that science has neglected the populace and offered its wares for popular edification in a highly unedifying way. I believe this is very true. I am old enough to remember different times, and can recall with truth and gratitude the feeling of enthusiasm, and even of exaltation, which I had in early days on hearing or reading popular science lectures. I think of Huxley, Tyndall, Clifford, W. B. Carpenter, Lockyer, Roscoe, and some others. Science lectures then were aimed at showing how science did its work, and they brought into view something of the personality of the real scientific worker.

Remembering how much I had gained, I endeavoured in my turn to carry on the good work within the much-restricted range of my own powers, but in the same spirit. In time I realised two things: one, the debilitating tendency of publicity and easily won applause; the other, the invasion of the science platform by the mere entertainer and his *entrepreneur*. The work became suspect to all self-respecting people. The degenerated Press has completed the havoc.

Is it not possible to improve matters? I believe it is. No doubt some knowledge of science is more prevalent than it was, but there is yet ample room for the simple, popular lecture of the genuine kind by men who are the real workers. It is a serious tax, but I am inclined to think a justifiable one, on the time of these men to give, say once a year in some large city, a really popular account of their latest discoveries and have it printed to sell at a popular price. That, and a vocal public opinion in the world of science against comic, pyrotechnic, mystic, or other profane tickling of the groundlings, might do much in a good cause. VICTORIAN.

Mirage Effects.

THE mirage effect noticed by Mr. Quilter and Miss Botley is very common on Woolacombe Sands, especially on hot, sunny days when the observer is looking south. The apparently wet patch keeps at a half to three-quarters of a mile's distance from the eye, but does not persist up to the southern limit of the bay, which is bounded by high ground. I cannot remember whether it is visible when the observer is facing north. SPENCER PICKERING.

MIRAGE effects similar to those referred to in NATURE of January 29 (p. 565) have been noticed by me several times in Birmingham on tarred macadam or wood-block roads. The effect on a hot, sunny day is of a layer of water from 2 in. to 4 in. deep on the surface of the roadway, immersed in which are the feet of pedestrians and the wheels of vehicles about a hundred yards from the observer. The effect is best seen when the line of sight nearly coincides with the surface of the roadway, as, for instance, just before one breasts the summit of a slight rise, when the eye is practically level with the ground beyond the top of the rise. Stooping would produce a similar effect. L. N. NORRIS-ROGERS.

I FIRST saw a mirage on a road in Colombo, and wondered how I was going to cross the apparent sheet of water in front of me. Since then I have seen it repeatedly in England, and instinctively look for it when the conditions are right. For the best effects these conditions are three: (*a*) Tarred roads (the reason is obvious); (*b*) bright sun; and (*c*) a slight gradient rising from the observer.

In very hot weather (*c*) may not be so necessary. At other times the mirage appears where the gradient reaches towards the level of the eyes. It is very clear, and reflections are as sharp as in water, especially of objects crossing near the further edge.

HARRY HILLMAN.

117 Colmore Row, Birmingham.

THE THEORY OF RELATIVITY.

THE meeting of the Royal Society on February 5 was devoted to a discussion on the theory of relativity. It was opened by Mr. J. H. Jeans, who said it was a better analogy to liken the new principle, not to a key of the universe, but to a ward in its lock, which gave direction to the efforts made to open it, admitting some and excluding others. In this respect it resembled the doctrine of the conservation of energy and the second law of thermodynamics. Where any of these gave a positive result it was because a process of exhaustion showed that anything else would be impossible.

The foundation of the theory may be considered to have been laid by Einstein's hypothesis, put forward in 1905, that light from any source appears to any observer to travel with the same velocity C; this hypothesis was founded on the Michelson-Morley experiment, and has since been confirmed by that of Majorana; it also explains a number of physical phenomena. It can best be visualised by the idea that to each observer the wave-surface is spherical in the four-dimension continuum. Then $x^2+y^2+z^2+(iCt)^2$ (radius for the first observer) transforms into an identical expression with accented letters (radius for the second observer) by a rigid-body rotation. Such a rotation would resolve pure time into partly time, partly space, and *vice versa*. The following is an example of this: Suppose that a man lives seventy-five years, and dies 1000 miles from his birthplace; then to an observer on a rapidly receding star he might appear to have lived seventy-six years and travelled billions of miles. (In reply to Prof. Newall, who imagined paper screens to be erected at a distance of 100 light-seconds from the origin, from which a flash of light is emitted, and from which one of the observers moves while the other remains, Mr. Jeans admitted that the former would not see the reflections simultaneously, the reason being that the screens would not lie on a four-dimensional sphere to him.) This conception was preferable to that of the Lorentz contraction, which presented grave difficulties in the case of a rotating wheel, the axis of which is at rest in the æther; the rim would undergo contraction, while the spokes would remain unaltered.

Mr. Jeans used the following analogy to explain the nature of Einstein's latest theory. Imagine a race of men who had spent all their lives in caves. They would be in ignorance of the earth's rotation, and would consider gravity as a force constant in direction; however, two experiments might reveal the fact of rotation to them. If they set a ball swinging in an ellipse, by a long string, the apse of the ellipse would move; moreover, delicate measures would show that the course of rays of light was not quite straight relatively to their rotating framework. This is closely analogous to the observed progression of Mercury's perihelion and to the deflection of light-rays by the sun; in each case "we have tacitly assumed fixed axes where nothing is fixed: we have formed wrong ideas of the nature of gravitation, and our definition of a straight line is interwoven with the ideas of an untrue system of geometry."

The reason why the new law of gravitation cannot be put in simple form is that there is no *force* of gravitation; the laws of *motion* can be put in the simple form $\delta\int ds=0$. There are, however, two ways of defining ds. Einstein defines it as a line-element in a distorted space-time continuum. This necessarily involves the spectral shift to the red, and an objective curvature of space. It may also be simply defined as a conventional algebraical symbol given by Einstein's equation, but without assuming his physical interpretation; in this manner it is possible to deduce the two astronomical effects already verified, while leaving the shift of spectral lines undetermined. Decisive evidence for or against the spectral shift would be a guide as to the adoption of one or other definition of ds.

Prof. Eddington compared Euclidean space to a picture in a framework of rectangular coordinates, and Einstein's space to a map with curved lines of latitude and longitude. Just as the map could not accurately represent the earth's surface, unless it was made on a curved surface, so Euclidean space could not contain an accurate representation of the space-time continuum. We could look on Einstein's law of gravitation as giving instructions for the joining together of successive elements of space. The law must include all the laws of mechanics, including the conservation of energy and momentum.

Space and time could be explored in two ways —either by using clocks and measuring scales, or by observing moving particles and light-waves. The second method was both more elementary and more sensitive. An example of it was the search for the spectral shift. The reason for the shift might be briefly given thus. The time of vibration of a particle involves the factor $\left\{1-\frac{2m}{rC^2}\right\}^{-\frac{1}{2}}$ which clearly increases as r diminishes, so that the vibration is slower on the sun than on the earth.

Sir F. W. Dyson spoke on the motion of the perihelion of Mercury; the observed centennial motion exceeds that calculated on the Newtonian law by 43″, which is much the largest unexplained quantity in planetary theory. Various attempts have been made to explain it. An excess of $\frac{1}{2}$″ of the sun's equatorial radius over the polar would suffice; this amount is considered to be in excess of what observation will admit; the latter suggests a slight excess of the polar radius; moreover, such an equatorial excess would produce a shift of the orbit-plane of Mercury too great to be admitted. An unknown planet is excluded, since it could not fail to have been seen or photographed at some of the total eclipses when such a body has been specially looked for. A ring of small planets would have to be in the plane of Mercury's orbit, or it would produce an effect on

its node and inclination. This puts the zodiacal light out of court, even if its mass were sufficient, which seems unlikely. Prof. Asaph Hall suggested that the law of attraction should be modified, the index of r being taken, not as -2, but as $-2(1+d)$, where d is a small fraction, chosen empirically so as to fit the case of Mercury. This is the law adopted in Newcomb's tables, and therefore in the Nautical Almanac. It would give a centennial shift of the moon's perigee of 135″. (The discussion of Dr. E. W. Brown seems to establish that there is no such excess of motion in the perigee, which discredits the Hall hypothesis.)

Einstein's theory perfectly explained the excess of motion of Mercury's perihelion, without introducing any arbitrary constant, or having any other perceptible effect on the planetary or lunar motions. By the method of exhaustion it seemed to hold the field. There remained a small excess of motion in the case of the node of Venus, but it was only $2\frac{1}{2}$ times the probable error, and so was not unreasonable.

Prof. A. Fowler spoke on the attempts that had been made to detect the shift towards the red in the sun's spectral lines, and on the difficulties in the way, which arose from the effect of varying pressure, the rotation of the sun, and possible convection currents in its atmosphere. A series of cyanogen lines was selected for the test, as they were not subject to shift through pressure; care was necessary to choose isolated lines, as adjacent lines might influence the measures. The sun's rotation could be eliminated by observing opposite points of the limb. The results of the measures of Evershed, St. John, Schwarzschild, and recent Bonn observers were shown on the screen. The mean of all gave a shift towards the red of 0·003 Å. at the sun's centre and of 0·004 Å. at the limb, Einstein's predicted value being 0·008 Å. Prof. Fowler inclined to the view that the observed shift was due not to the Einstein effect, but to cooler descending convection currents at the sun's centre, and to the "limb effect" at the limb.

Mr. E. Cunningham gave the following example to show that the spectral shift need not necessarily occur on the equivalence hypothesis: Imagine two atoms each emitting light-vibrations in a non-gravitational field, the periods of vibration being the same. Referring them to a set of accelerating axes, we simulate a gravitational field. The synchronism between the two sets of waves is not destroyed; and on the equivalence hypothesis the relation of physical sequences in the simulated field is the same as in the real field. There is the qualification that the atoms must be free to fall—*i.e.* not constrained by neighbouring atoms; Mr. Cunningham doubted whether this was the case on the sun's surface. He went on to say that relativity did not necessarily imply the abandonment of the æther; a unique æther could be constructed on a mechanical basis; if it transmitted light, it must also transmit stress and energy.

Prof. A. F. Lindemann spoke of the observed average recession of 4 km./sec. in the B-stars; even those in the Orion nebula, which presumably were at rest relatively to it, showed this differential shift; he concluded that it was not a Doppler effect, and might be the Einstein one. He noted as a difficulty in the quantum theory of light that to an observer at rest the mass of a quantum would be infinite; moreover, he considered that since the mass of an electron changed with its speed, its period of vibration should also change. Speaking of Prof. Eddington's statement that a sphere of water of radius 500 million km. would fill all space, he preferred to say that to an observer on the sphere it would appear to do so, since all rays from it would be bent back to it by its attraction; but he thought there was nothing to prevent other space from existing outside it.

Prof. A. N. Whitehead showed a mathematical method by which Einstein's first two astronomical predictions might be satisfied without introducing time as the fourth dimension. The method left it uncertain whether the spectral shift would take place or not. Should the latter be finally proved not to exist, we might fall back on this method, which agreed with the facts at present observed.

A. C. D. CROMMELIN.

THE FLIGHT FROM CAIRO TO THE CAPE.

(1) AVIATION AND EXPLORATION.

THE enterprise of the *Times* in organising a flight from London to Cape Town *via* Cairo, Khartum, the Upper Nile, the interior of East Africa, Northern and Southern Rhodesia, and the Transvaal will certainly, if successful, greatly advance the theory and practice of travelling through the air from one distant part of the world to another.

The bearing of the whole question—air travel *versus* railway, ocean steamer, or road-motor transit—was well put a few days ago by Capt. Frederick Shelford in his address to the African Society. There is no real cause for rivalry or hostile competition between all four forms of rapid transport. Air travel by aeroplane or airship will for a long time to come be far more dangerous to life than road or rail transit, and a little more dangerous than sea voyages; but it will be very much quicker than all other methods. It will be impossibly expensive for the transport of goods or of many passengers. Sea travel by boat is the cheapest mode of conveyance; railways, on the whole, and especially in wild, little-developed countries, are as cheaply made as motor roads, and are much less expensive to maintain. For mails and for passengers in a great hurry, aeroplanes should have no rival, especially when meteorology is better understood, and when the great air routes of the world are duly provided with aerodromes at convenient distances.

It may seem to be stating too obvious a fact

when I point out that the chief difficulty in the way to complete success on the part of aviation is the coming down safely from the air to the solid earth. No air pilot can view without grave apprehension a forced descent on an uneven or merely a slightly irregular surface. The passengers might not be more than shaken or bruised, but the delicate machine might be so injured as to be unable to resume its flight. But for this trouble about *descent* and *ascent*, the exploration of the world's land surface would now be proceeding at a tremendous rate. Soon the whole of the continents and islands would be made known in all their details.

I have always hoped myself that there may be some wonderful development in mechanics or in physics by which heavier-than-air machines might be enabled (1) to rise direct from the ground into the air *vertically*; and (2) to descend vertically and slowly, under control, making use of air-brakes in some way. The latter process may read as an impossibility, but it is not more improbable than many a feat in aviation would have sounded to the scientific theorist twenty years ago.

Then, again, I am sure we have neglected another safety apparatus: the devising of clothing that might be so inflated with air that the wearer would float to earth as gently as thistle-down.

The original mind of Dr. Chalmers Mitchell may well come back from his great air journey with new conceptions as to the future solution of these and other difficulties in aviation. Few people know as much as he does about bird-structure, and he may, when he is "up against it," be inspired to apply to the theory and practice of aviation some bright ideas—as yet overlooked—to be derived from the bird's development of the art of flying, especially the efforts made by heavy birds (cranes, storks, swans, peafowl, bustards, and large vultures) to rise into the air, to maintain themselves resting (floating) in the air, and to descend from a great height to the ground uninjured.

As to Dr. Mitchell's experiences and those of his companions on this actual journey, my impressions are: that by rising to eight or nine thousand feet they will ascend above the dangerous storms or violent winds of Central Africa; that they will nowhere run any serious danger from wild or savage men, except among the Dinkas of the Nile Valley (east of the Bahr-al-Ghazal); that they have very little to fear from any wild beast except a chance rhinoceros in East Africa; and that in seeing the desert yield to the Nile marsh-lakes, the marshes give place to mountains—even snow-mountains—and grandiose forest, the forest thinning out into parklands, the parklands passing into steppe, the steppe into desert, and the desert into the cornfields, orchards, vineyards, and gardens of South Africa, they will have had an unforgettable lesson in physical geography. I wish them the most complete success and a happy return.

H. H. JOHNSTON.

(2) SCIENTIFIC ASPECTS OF THE ROUTE.

THE expedition which started from Cairo on February 6 should be memorable as the first use of long-distance aeroplane flight for scientific and geographical research. Thanks to the enterprise of the *Times*, a Vickers' "Vimy" aeroplane is traversing Africa from Egypt to the Cape, with Dr. Chalmers Mitchell as scientific observer and Capts. Cockerell and Broome as pilots. The expedition will test the value of long aerial journeys for scientific purposes, and as it is under a man of such width of knowledge and scientific imagination as Dr. Chalmers Mitchell, we may be confident that the opportunity will be used to the best advantage.

The expedition is to travel leisurely, at moderate elevations, and never flying at night, so as to enable Dr. Chalmers Mitchell to obtain a clear survey of the country traversed. The route is from the aerodrome at Heliopolis, near Cairo, up the Nile, past Assuan, to Wadi Halfa, and thence, along the railway line, across the Dongola bend of the Nile, to the river again past Atbara to Khartum; then up the White Nile past Mongalla and Gondokoro and over the Nile rapids to Nimule. Thence the most direct route would be to leave the river and cross the Fatiko country to Lake Kiogo, and there rejoin the Nile, following it to its outflow from the Victoria Nyanza at the Ripon Falls. The expedition will fly over the lake to Kisumu, at the end of the Uganda Railway, skirt the irregular eastern coastlands to Mwanza, on the southern shore of the Victoria Nyanza, and cross "German" East Africa to Abercorn at the southern end of Tanganyika. Thence the route will be above north-eastern Rhodesia to the mining fields of the African Broken Hill, and along the railway past the Victoria Falls on the Zambezi to Wankie coalfield and Bulawayo; it will continue in sight of the railway another 182 miles southward to Palapye, where it will bend eastward across the northern Transvaal to Pretoria, and by following the railway past Johannesburg, Bloemfontein, and Beaufort West end its journey, of 5206 miles by the route projected, at Cape Town.

This journey must naturally be direct, long distances must be covered daily, and deviations to follow up interesting clues may be inadmissible, for the main object of this flight is to demonstrate the practicability of the aeroplane in the next stage of African research and development. The prospects are promising, for a bird's-eye view from a moderate elevation would reveal much of interest and practical value regarding the geography, geology, and botany of those parts of Africa composed of arid plains like the East African Nyika. One difficulty with their investigation is that, owing to the covering of scrub, travellers by foot or on horseback may march for days and see nothing beyond a few hundred yards beside the route, while any useful plane table survey is impossible. A view from above would, however, show all the essential features; the valuable areas are on the volcanic rocks or on limestones, both

of which produce good soils and often maintain permanent wells, whereas the metamorphic rocks, which form the foundation of the country, yield a barren sandy soil and may have no permanent water.

The contrasts between the types of country on these three kinds of rock are so striking that an aeroplane observer would soon learn to distinguish them and thus discover potential oases on lava or limestone in the wastes of sandy scrub. In such countries travel to a physiographer is often as exasperating as the sudden interruptions of view along a railway by lines of obstructive trees, cuttings, and tunnels, which led Ruskin to renounce railway travel, on the ground that he would as soon thus hasten a journey across interesting country as an epicure would compress his meal into a single pill. Moreover, the traverse of these arid plains in the dry season is hazardous, as a caravan strong enough for necessary transport and defence is liable to disaster by failure to find water; whereas an accompanying aeroplane scout would at once discover any remaining waterholes, which might be concealed from a caravan passing a short distance from them. Aeroplane guidance might thus enable an expedition to cross an area which otherwise it would be foolhardy to enter.

The motor-car is no doubt of great service on these plains in dry weather, but its use is attended with the serious danger that a sudden fall of rain may convert the country into a sea of mud, in which the motor is immovable. A premature rainstorm before the normal rainy season may leave a party dependent on motor transport as completely isolated in the desert as a shipwrecked party on an oceanic island.

African geography is in a stage when bird's-eye views may be very instructive. For example, south-west of Lake Stefanie different explorers have reported lines of hills and scarps the interpretation of which is at present uncertain; but to an aeroplane observer surveying the country, especially when helped by the long shadows of early morning or late afternoon, these lines would appear in such diagrammatic outline as to give him an insight into their relations, which would cost a traveller on foot an arduous season's campaign. Similarly, there is much difference of opinion as to the connection between Lake Nyasa and the southern end of the Rift Valley in central "German" East Africa near Kilimatinde; the Ruaha Valley overlaps with a relief line to the north-west of it, but no connection between them has been recognised. An aeroplane survey of this region under suitable illumination would demonstrate the structural relations between the chief features in the relief of the area with a speed, an ease, and an economy which no other method could approach. Again, in the area which the *Times* expedition will skirt in going from Tanganyika to the mines at Broken Hill, the structural geography is complex, including valleys and scarps of different dates and plateaux of sandstone of various undetermined ages. The traverse of this district is arduous, and comprehensive views across it are difficult to obtain. But a survey or looking down on it, especially if able to hover over it at leisure and see it from different angles and under various conditions of illumination, would probably contribute greatly to the solution of its leading tectonic problems.

Dr. Chalmers Mitchell's traverse, being an experimental journey, will probably be unable to make many deviations for scientific study, but it is following a route of exceptional interest, and we may expect light from him on some East African physiographic problems, such as the controversy as to whether the Lower Nile Valley is a down-folded basin or a down-faulted trough, or as to the relations of the young valley which the Nile is excavating north of Khartum to the older river which drained that area. His survey of the northern face of the plateau north of Uganda, seen from a distance which will blot out the minor irregularities, may throw light on its origin; and during his flight from Nimule to the Victoria Nyanza he may discover some line of depression continuing the tectonic subsidence north-east of the Albert Nyanza towards Lake Rudolf. In addition to work of this character, enabling Africa to be studied like a great relief model, the value of the aeroplane in scientific work will probably be mainly as a means of rapid transport to centres for study or help in emergencies.

The cost of aeroplane transport may seem large when compared with railway rates of a penny per ton-mile; but it is insignificant in comparison with that of a caravan across a foodless territory, when each porter can carry so little in addition to his food that the cost of the carriage of goods from Mombasa to Uganda was reckoned at 300*l.* a ton. The aeroplane will doubtless enable the arid areas in East Africa to be investigated at a much cheaper rate than any other available method.

In the political administration of Africa, Dr. Chalmers Mitchell's mission may lead to ultimate economy in many districts. Thus, in northern British East Africa, garrisons are so isolated, and so liable to sudden calls to control the nomads or to resist Abyssinian raids, that they must be maintained at costly strength; but a periodic aeroplane inspection of the desert lands on the borders of British East Africa would reveal the whereabouts of the tribes and discover whether there were any concentrations of men and camels which threatened mischief; and thus it would add greatly to the efficiency of the frontier guard.

From its bearing on African administration, on an accelerated postal service, on quicker and cheaper transport of officials and investigators, as well as for its direct observations, the journey of Dr. Chalmers Mitchell and his companions may mark the beginning of a new epoch in African travel.

J. W. GREGORY.

(3) CIVIL AVIATION.

THE lecture by Major-Gen. Sir F. H. Sykes on "Imperial Air Routes," which was delivered before the Royal Geographical Society on February 2, will be eagerly read by all interested in the future of

civil aviation. Sir F. H. Sykes spoke upon the great advantages to be gained by the establishment of a complete system of aerial routes linking up the widespread portions of the Empire, with Egypt as the "Clapham Junction" of the India, Australia, and Cape routes. The last route was discussed at some length, and an account given of the work which has been done in establishing a chain of aerodromes from Cairo to Cape Town. The great usefulness of the aeroplane as a means of reaching outlying places near the route which have at present no rapid means of conveyance was commented upon.

The main outline of the lecture is summed up as follows :—

"It is not enough to believe—as I firmly do—that aerial transport being right is bound eventually to succeed. The seasoned tree can stand alone; the shooting sapling must be stayed. Some of the requirements of aviation on an Imperial basis are :—

"(1) The maintenance of a highly efficient fighting force.

"(2) The expansion of commercial aviation to promote British trade and to supplement the fighting force when necessary by a reserve of *personnel* and material, knowledge and experience.

"(3) The co-ordination and co-operation of aerial communication throughout the Empire, and its relations to other countries.

"(4) The organisation of routes, aerodromes, ground communication, and meteorological services on an Imperial basis.

"(5) The energetic promotion of research and the encouragement of design.

"(6) Money to assist the institution of experimental mail services.

"(7) The encouragement of land survey, forest patrol, and other work in which aircraft can be utilised.

"This year will, I hope, go down to history as marking the birth of a sound, virile, and truly Imperial air policy."

As a practical commentary on the lecture comes the projected *Times* flight by a Vickers' "Vimy" aeroplane from Cairo to the Cape, referred to last week, over the route described by Sir F. H. Sykes. The machine left Cairo at 9.45 a.m. on February 6, and reached Khartum on February 8, leaving there on February 10. Should the flight along the African continent prove a success, the feat will be the third great triumph for this type of aeroplane, the present machine being practically identical with those which accomplished the Atlantic and Australian flights. The crew consists of two pilots, one mechanic, and a rigger, while the well-known zoologist, Dr. P. Chalmers Mitchell, is passenger and scientific observer. The object of the flight is primarily to determine the possibilities of the new route, but it is also to be regarded as the first attempt at exploration from the air, as much of the country to be crossed is at present unsurveyed. The result of this experiment will be awaited with interest. If success is achieved, a new proof of the commercial possibilities of the aeroplane will have been established—a proof that should convince the most sceptical.

THE DEVELOPMENT OF SPITSBERGEN.[1]

IN view of the increased public interest in Spitsbergen on account of the revival of mining activity and the recent political settlement, Dr. R. N. Rudmose Brown's new book upon the country is particularly opportune. It is further welcome because it provides the only modern work in English dealing with Spitsbergen in its general aspects; for Sir Martin Conway's "No Man's Land" is an historical volume, narrating the discovery and the early history of whaling and hunting in the archipelago and the adjacent seas. The only other recent general works are those of Holmsen in the Norwegian, and of Cholnoky, curiously enough, in the Magyar language.

Whatever its mining possibilities are (and scepticism has recently arisen), the situation of Spitsbergen as the most easily accessible polar land, along with its wonderful climate, will inevitably lead to its becoming a favourite European playground. In summer, Spitsbergen has a climate, especially in its central and western regions, which is a good deal more tolerable than the average British spring; and, apart from the drawback of polar darkness, its winter climate is said to compare quite well with that of Canada. It has glorious mountain, fiord, and glacier scenery, and the study of its spectacular physical features and natural history will afford exhaustless attractions for scientific travellers.

Dr. Rudmose Brown's book first deals pleasantly with the discovery, physical features, climate, and natural history of the Spitsbergen Archipelago, the geology, however, being deferred to the chapter describing its mineral wealth. The succeeding chapters trace the history, exploration, and economic development of the country. Spitsbergen history may be divided naturally in order of time into the whaling, hunting, exploratory, and economic periods. The whaling industry has been extinct for a century or more. Hunting and trapping have recently revived, after a period of exhaustion, in response to the high prices now obtainable for furs. Dr. Brown records and deplores the unfair and ultimately disastrous poisoning methods practised by some Norwegian hunters. The Norwegian Government, it is hoped, may now be able to deal adequately with this and other crying abuses.

The mining development of Spitsbergen dates from 1904, although coal and other minerals had been found much earlier. The only large-scale mining has been in the excellent Tertiary coal of Advent Bay, which was opened up by an American company, but is now carried on by Norwegians. In 1912 40,000 tons were raised, but in 1919 it is believed that this total will have been more than doubled. While British companies claim areas more than three times as large as those of all other nationalities combined, the war unfortunately stopped their development schemes, and it was only in 1918 and 1919 that they were able to resume their activities and send up prospecting expeditions.

Besides coal, iron ore of good quality is said to occur; gypsum is certainly present in enormous amount; and traces of copper, gold, molybdenum, lead, and asbestos have been found. Oil and oil-shales are possibilities. Nevertheless, Norwegian geologists, who for the last ten years have carried

[1] "Spitsbergen: An Account of Exploration, Hunting, the Minera Riches and Future Potentialities of an Arctic Archipelago." By Dr. R. N. Rudmose Brown. Pp. 319. (London: Seeley, Service, and Co., Ltd., 1920.) Price 25s. net.

on extensive prospecting work, especially in the western mountain ranges, are very sceptical as to

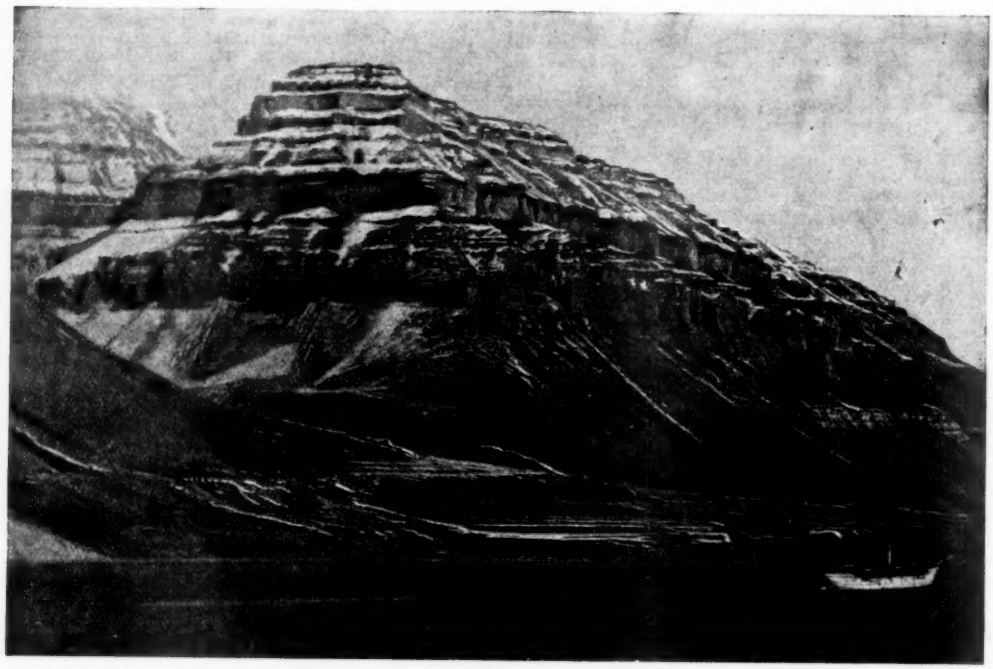

FIG. 1.—Temple Mountain from Bjona Haven. The Prince of Monaco's yacht, the *Princess Alice*, at anchor. One of the most important British estates in Spitsbergen is situated here. From "Spitsbergen."

workable mineral resources, except coal, as may be gathered from a perusal of recent correspondence in the *Mining Magazine*. A fierce but feeble answer to these letters by a representative of a British company interested in Spitsbergen fails to meet the facts brought forward by the Norwegian geologists, especially in regard to metalliferous ores. The reviewer believes that mining development in Spitsbergen will rest largely upon coal, with perhaps oil and oil-shale, obtained from the flat-lying rocks of the central tracts.

The later chapters of the book discuss certain German schemes for the exploitation of Spitsbergen, now happily brought to naught, its modern history, and its political status. Spitsbergen is no longer a No Man's Land, and the last chapter of Dr. Brown's book is therefore already outdated by the decision of the Supreme Allied Council to assign the sovereignty of Spitsbergen to Norway.

The twenty-two plates illustrating the book are excellent and doubtless contribute to its high price, but the two maps are comparatively poor.

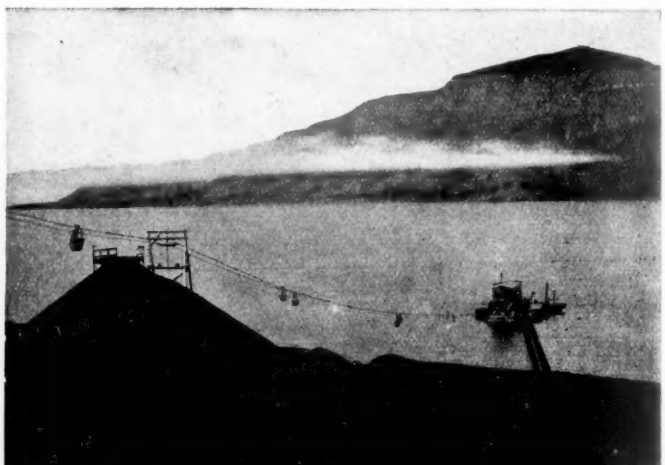

FIG. 2.—Longyear Mine, Advent Bay. Wire ropeway from the mine, coal dump, and jetty with a vessel loading alongside. From "Spitsbergen."

Mistakes and misprints are commendably very few. "Ordovician" is misspelt on p. 216, and there is a discrepancy in the story of Klaus Thue's wintering on p. 106. A bibliography of the more

important works on Spitsbergen would have enhanced the value of the book to interested readers, who will nevertheless find it the best available compendium of Spitsbergen information.

G. W. T.

THE LEAGUE OF UNIVERSITIES.

A REPRESENTATIVE body of British university men and women spent the autumn of 1918 in America as the guests of the United States. By invitation of the Government of the French Republic a similar delegation visited the universities of France last May. From the Belgian Government an invitation was received and accepted in November. The reports of these three university missions may be obtained from the Universities Bureau, 50 Russell Square, W.C.1. In each of the countries visited the representatives of the United Kingdom were received with profuse hospitality and treated with the utmost consideration by the Head of the State and his Ministers, as well as by the heads of the universities and their professors. In innumerable speeches the general objects of this university "entente" received eloquent and enthusiastic expression, stress being laid upon the necessity, in the interests of the world's peace, of bringing the intellectual leaders of the allied and associated countries into closer and permanent touch. There may be rivalry amongst the universities of the civilised world, but there can be no competition, in the sense in which commercial enterprises compete, with the risk of producing discord. All are engaged upon a common task, the making of knowledge, and the training of men and women for professions and occupations in which learning is the only trustworthy equipment.

During the last three or four years the universities of the United Kingdom have discovered that their power and influence may be greatly strengthened by taking counsel together, without any sacrifice of independence. There is the same need for conference and co-operation amongst the universities of the world. Amongst definite problems discussed was the interchange of teachers and students—the migration of those who dispense and of those who seek knowledge, adjusted to modern conditions. The reports of all three missions are in approximately similar terms. It is recognised that professors who are heads of departments have many administrative duties in addition to their duties as teachers. Their universities cannot spare them for any considerable time, nor can their duties be taken over by strangers. Heads of departments might with great advantage give short courses of lectures in foreign countries, provided the language difficulty can be overcome. Professors of highly specialised or recondite subjects, for which the demand is limited or occasional, might well distribute their services amongst several universities, spending an occasional year abroad.

With regard to migration of students, it is clearly desirable that students of languages should spend a part of their undergraduate career in foreign countries; but with this exception it is almost universally agreed that only in rare instances would it be to the advantage of a student to leave the university in which he is matriculated until after graduation. The first year's work at any one university is not easily articulated to the second year's work at any other. Nor would any university be content to part with its third-year students. For a graduate, every possible facility for migration should be afforded. Even though his new university be not so well equipped for work in the subject to which he is devoted, it is to his advantage that his experience should be enlarged. So far as British universities are concerned, post-graduate study will be encouraged by the new Ph.D. degree which all have now established. The same degree is obtainable in the U.S.A., and its equivalent, the doctorat de l'Université, in France and Belgium.

NOTES.

THE new session of Parliament was opened in state on Tuesday by the King, who was accompanied by the Queen and the Prince of Wales. Among the matters referred to in the King's Speech were a Bill to make further provision for education in Ireland, measures to stimulate and develop the production of essential foodstuffs within the United Kingdom, and to encourage and develop the fishing industry, and Bills providing against the injury to national industries from dumping and for the creation of an adequate supply of cheap electric and water power.

As successor to the late Mr. Henry Watts in the editorship of the Journal of the Chemical Society, and as the first secretary and registrar of the Institute of Chemistry, Mr. Charles Edward Groves, F.R.S., was for many years a very prominent figure in the chemical world. His scientific education was received under Hofmann at the Royal College of Chemistry, where he was contemporary with a group of young men of whom many became distinguished men of science. In October, 1862, Mr. Groves became senior assistant to Dr. John Stenhouse, F.R.S., who had established a private laboratory for research in Rodney Street, Pentonville, and there he remained as factotum until Dr. Stenhouse's death in 1880. He then became lecturer in chemistry at Guy's Hospital. The greater part of Mr. Groves's scientific work was done in the Pentonville laboratory, and was published under the joint names of Stenhouse and Groves, though, in consequence of Dr. Stenhouse's infirmity, the work was mostly done by his assistant. Mr. Groves was a good manipulator and a skilful analyst, and not only assisted in the research laboratory, but for five years also took part in the work of external assayer to the Royal Mint—an office held by Dr. Stenhouse until 1870, when it was abolished. Mr. Groves in his early days was a very active walker and climber in the Alps. For many years he spent his summer holidays in Switzerland, and will be remembered by many of the senior members of the Alpine Club. His death on February 1, at an age approaching eighty years, leaves

but few survivors of the original group of students of the Royal College of Chemistry.

THE Carnegie Corporation of New York has announced its intention to give five million dollars for the use of the U.S. National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organisations. The remainder will be placed in the hands of the academy, which enjoys a Federal charter, to be used as a permanent endowment for the National Research Council. This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry. The Council is a democratic organisation based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent divisions. It is not supported or controlled by the Government, differing in this respect from other similar organisations established since the beginning of the war in England, Italy, Japan, Canada, and Australia. The Council was organised in 1916 as a measure of national preparedness, and its efforts during the war were mostly confined to assisting the Government in the solution of pressing war-time problems involving scientific investigation. Reorganised since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science.

SIR HENRY FOWLER has been elected president of the Institution of Automobile Engineers for the session 1920–21, and Dr. Blackwood Murray, Lt.-Col. D. J. Smith, and Mr. Geo. Watson vice-presidents.

THE National Sea Fisheries Protection Association has decided to form an organisation, to be known as the British Fisheries Guild, with the following objects:—(1) To gather and diffuse information upon all matters relating to fish and fisheries, and to collect and circulate statistics relative thereto; (2) to unite, encourage, and maintain all interests relating to fish and fisheries, and to affiliate local or other organisations with similar objects; and (3) to deal with all questions relative to fish and fisheries, whether scientific or economic in character.

AT the meeting of the Royal Anthropological Institute to be held on February 17 Mr. J. Reid Moir will exhibit and describe certain flint implements and flakes found in the Boulder Clay in pits north of Ipswich and at Claydon. Prof. J. E. Marr is of the opinion that this deposit represents part of the large sheet of Boulder Clay of the Ipswich sheet. Mr. Moir's examination of the form and technique of these implements has led him to the conclusion that they may with probability be referred to the Mousterian phase of culture.

MR. F. H. CARR has just been elected to a seat on the board of directors of the British Drug Houses, Ltd. After holding for several years the Salters' research fellowship, first at the Pharmaceutical Society's research laboratory and afterwards at the Imperial Institute, where he specialised on the active principles of drugs and became a leading authority on alkaloids, Mr. Carr was appointed chief of Messrs. Burroughs Wellcome and Co.'s Chemical Department. In 1914 he was appointed a director of Boots Pure Drug Co., from which position he resigned at the end of the war.

A RADIO Research Board has been established by the Department of Scientific and Industrial Research to co-ordinate and develop researches into wireless telegraphy and telephony at present being undertaken by Government Departments. The members of the Board are:—Admiral of the Fleet Sir Henry B. Jackson, G.C.B., F.R.S., chairman; Comdr. J. S. Salmond, R.N., Lt.-Col. A. G. T. Cusins, C.M.G., Wing-Comdr. A. D. Warrington Morris, C.M.G., Mr. E. H. Shaughnessy, and Prof. J. E. Petavel, F.R.S.—representing the Admiralty, War Office, Air Ministry, Post Office, and Department of Scientific and Industrial Research respectively—and Sir Ernest Rutherford, F.R.S.

ELEANOR ANNE ORMEROD, the distinguished student of economic entomology, lived at Torrington House, St. Albans, from 1887 until her death in 1901, and it was during her residence there that she achieved the final success of her great project to convince the general agricultural public that an accurate knowledge of the life-history of injurious insects was worth having, because it provided the only sure foundation for preventive and curative measures. To commemorate her residence in the county, the Hertfordshire Natural History Society has lately put up a tablet at the gate of Torrington House on Holywell Hill, which will help to keep alive the memory of Miss Ormerod's splendid record of unselfish work.

INFLUENZA is still far from assuming anything approaching an alarming epidemic, although the Registrar-General's return for the week ended January 24 showed a slight increase. In London the deaths were 24, which is rather more than in any week since the commencement of last autumn, but the deaths in the week ended January 31 are nine fewer than in the preceding week. The deaths for the ninety-six great towns of England and Wales, including London, in the week ended January 24 were 85, also the highest in any week since last autumn, but the following week shows a decrease of 19. Both December and January were remarkably mild, which, guided by the weather associated with previous epidemics, is scarcely in favour of lessening an outbreak. So far as can be judged at present, the general health over England and Wales seems highly satisfactory.

JANUARY was very mild over the British Isles with the exception of the first week, when the mean for the United Kingdom generally was nearly 2° F. below the normal. The weekly weather reports issued by the Meteorological Office show that the mean temperature for the second week was, taking the British Isles as a whole, 4° above the normal, and in the third week the excess was 2·3°, whilst for the closing week the excess for the whole kingdom was 1·6°, a deficiency of temperature occurring in Ireland. In each week the rainfall was in excess of the normal

over England. The Greenwich records show that the mean temperature was continuously above the average after the first week. The mean for the month was 42·1°, which is 3·6° above the normal for the last thirty-five years; the mean maximum was 4·9° in excess, and the mean minimum 2·1° in excess. There were fourteen days with the thermometer at 50° or above, and on four days the temperature was 55° or above. So far as London is concerned, January was warmer in 1916, when at Greenwich the mean temperature for the month was 3° warmer than January this year; the January mean for 1916 was 45·3°, whilst for 1917 it was 35·3°. In Canada January was abnormally cold, the contrast with the British Isles resembling greatly the winter of 1898–99. For the nine weeks of winter from November 30 to the end of January there was an excess of temperature, and also of rainfall, over the British Isles. The controlling factor was the frequent passage of disturbances from the Atlantic, the centres of which, for the most part, travelled in proximity to Scotland.

THE twelfth annual report of the National Museum of Wales for 1918–19 is a record of steady progress. Considerable advance has been made in the formation of the Welsh portrait and topographical collections, which will in the near future be extensively used for educational purposes and for circulation. The most important accession to the zoological department was the collection of British Lepidoptera and birds' eggs presented by Mr. A. F. Griffith, of Brighton. Specimens, models, and drawings are being collected with the view of forming a Welsh Naval and Military Historical Record, including aviation, which will not be confined to recent years, but will embrace naval and military incidents connected with Wales or in which Welshmen have taken a conspicuous part. The importance of the museum for education in Wales is shown by the use of the collections for special studies in different branches of natural science, and by visits paid by parties of mining students to Cardiff for the purpose. The museum officials do good service in answering inquiries on scientific questions and by identifying specimens submitted for examination.

THE Syndics of the Cambridge University Press have issued a new Catalogue, to which is prefixed an interesting note on the progress of printing in Cambridge. The first printer, John Siberch, settled there in 1521, and eight books have been found bearing his imprint. The modern history of the Press may be said to have begun in 1698, when, thanks to the labours of Richard Bentley, a great revival of typography took place. Additions were made to the buildings, new presses set up, beautiful types imported from Holland, and a body of Curatores Præli Typographici, of whom the Press Syndics of the present day are the successors, was appointed. One of the most famous English printers, John Baskerville, entered into an agreement with the University in 1761. Early in the nineteenth century stereotype plates, the invention of the third Earl Stanhope, were successfully used. In 1824 part of the surplus of the fund for erecting a statue of William Pitt was devoted to the new Press buildings; J. W. Parker (1836–54) was the first to introduce steam-power; and since then under the control of the Clay family—John Clay, the late printer, died in 1916—and of the present printer, Mr. J. B. Peace, the work of the Press has rapidly extended its operations, the result of which is fully illustrated in the new Book Catalogue.

IN the "Historical Collections of the Essex Institute" (vol. lvi., part i., January, 1920) Mr. F. B. C. Bradlee gives an interesting account of the maritime history of Newburyport, Massachusetts. Many famous vessels sailed from this old Essex County city, among the best known of which was the *Dreadnought*, built in 1853, and afterwards celebrated for making the shortest passage across the Atlantic ever accomplished by a sailing vessel—nine days and seventeen hours from Sandy Hook to Queenstown. She was named by sailors the "Wild Boat of the Atlantic," and was a semi-clipper, possessing the merit of being able to bear driving as long as her sails and spars would stand. Mr. Bradlee, in opposition to what he calls "a small coterie in New York," claims to have proved the correctness of the records of this famous voyage of the *Dreadnought* in 1859, and gives a full account of later ships sailing from Newburyport.

IN the issue of the Annals of the Natal Museum for May, 1919 (vol. iv., part 1), a valuable paper is contributed by Mr. Claude Fuller entitled "The Wing Venation and Respiratory System of Certain South African Termites," illustrated by eight folding plates. The author's observations on the development of the wing-veins have been directed towards an investigation of the conclusions of Comstock and Needham. One of the main points wherein he differs from the American authors is in the origin of the wing tracheæ. It is remarked that the tracheæ of the wing-sac develop from two or three buds, arising from the spiracular trunk tracheæ of the meso- and metathorax, and not upon the dorsal and ventral longitudinal trunks, as enunciated in the general scheme of Comstock and Needham. In a recent book by Comstock, "The Wings of Insects" (1918), which apparently was issued while Mr. Fuller's paper was in the press, an article is contributed by Chapman on the basal connections of the wing tracheæ, and it appears that these recent observations are more in accord with those of Mr. Fuller than the earlier American work. It is evident, however, that the origin of the wing tracheæ in termites is less primitive than in some other insects. The remainder of the paper deals with the spiracles and the tracheal system as a whole, together with a study of the venation in the completed wings of various species and of the wide range of variation exhibited therein.

IT is well known that when America was discovered maize was widely cultivated by the aborigines, but the wild source of the plant has remained obscure. Various views concerning its origin have been entertained, one being the theory of Mr. Collins, based on breeding experiments and morphological comparisons, that maize arose as a hybrid between the Mexican teosinte (Euchlæna) and some unknown grass belonging to the Andropogoneæ. Mr. Y. Kuwada in

an interesting paper (Journ. Coll. Sci. Imp. Univ. Tokyo, vol. xxxix., art. 10) has studied the chromosomes of maize and its relatives, and brings cytological evidence in support of Mr. Collins's hypothesis. Maize, as well as Euchlæna and Andropogon, is found to have ten pairs of chromosomes, but those of Euchlæna are longer than those of Andropogon, while in maize they are found to be of different lengths, a pair frequently being composed of a longer and a shorter chromosome. From this it is concluded that maize is hybrid in origin, the two types of chromosomes being traceable as in certain experimentally produced animal hybrids. Some races and individuals of sugar-maize are found to have eleven or twelve pairs of chromosomes, which is attributed to cross-segmentation of one or two pairs. It would appear that in the origin of the many known varieties of maize, a considerable number of which were grown by the natives in different parts of the American continent, hybridisation and mutation may have gone hand in hand.

THE United States Department of Agriculture is publishing a folio atlas of American agriculture. Part ix., section i., deals with rural population, and contains thirty black-and-white maps and diagrams based on the census returns of 1910. Among the most interesting maps are two showing respectively the increase and decrease in rural population between 1900 and 1910. Increase was mainly in the Pennsylvania mining district, in the cotton belt, in the newly developing agricultural regions of the west, and around cities. Decrease was most marked in the maize and winter wheat region. It is explained by the consolidation of many small farms into a few large ones in order to secure the full benefit of the use of machinery and large-scale production. The decrease in population in these districts is mainly a measure of their productiveness. Of much interest, too, are the maps showing the distribution of native white, foreign, and negro stocks. For this purpose all people are classed as foreign who either were born abroad or one or both of whose parents were born abroad. A series of maps shows the distribution of foreign population by countries of origin. In both urban and rural populations the Germans are the principal nationality of foreign stock, and the Irish the second. Except in the case of Norwegians, Danes, and Swedes, the foreign element is more noticeable in the urban than in the rural population. A map illustrating the percentage of the rural population unable to speak English shows a high proportion in the west and north, particularly in Wyoming, North Dakota, and Minneapolis, where the Russian and Scandinavian elements are marked, and in Pennsylvania, with its comparatively recent influx of Slavs, Hungarians, Germans, and Italians.

A GOOD geographic account of the Mackenzie River basin has been drawn up by Messrs. C. Camsell and Wyatt Malcolm for the Geological Survey of Canada (Memoir 108, 1919). It has an eminently practical bearing, and should guide those seeking new agricultural lands or new fields for industry in the North-West.

M. L. DE LAUNAY furnishes an important review of the mineral resources of Alsace-Lorraine in the *Revue Scientifique* (November 15, 1919, p. 673). It is interesting to note that this article arose from a lecture given in the recovered town of Metz, which lies at the south end of the great field of oolitic iron-ore. Sketch-maps are given of this field and of the potassium and petroleum areas in the Rhine-vale.

THE importance of algæ in the formation of limestone is further emphasised by the publication of Mr. W. H. Twenhofel's paper on "Pre-Cambrian and Carboniferous Algal Deposits" (*Amer. Journ. Sci.*, vol. xlviii., p. 339, November, 1919). In the massive cases here described it is held that the calcium carbonate does not enter into the tissues of the plant, but is deposited, as in so many recent travertines, by the lessening, through the activity of organisms, of the capacity of the water to retain the salt in solution. The deposits are thus of the nature of laminated encrustations.

THE Monthly Bulletin of the Hawaian Volcano Observatory, which is always noteworthy for its unique illustrations, gives (in vol. vii., No. 8, August, 1919) a fine picture of a lava-rush in a cave, photographed in June, 1919. The work of observation has been rendered far more interesting for readers of NATURE since the publication of the views of the great topographic model, in which the situation of the scientific station is clearly shown (NATURE of August 7, 1919, vol. ciii., p. 456). Mr. E. S. Shepherd gives a number of analyses of the gases collected from Kilauea in Bulletin No. 7, 1919, showing a "surprisingly high" amount of water.

THE appearance of a memoir of 300 pages on "The Geology of the Country around Lichfield" (Mem. Geol. Survey, England and Wales, 1919, price 9s.) makes us once more wish that some relic of the Colby-Portlock plan, hazarded in Ireland in 1840, had been allowed to remain in our Geological Survey organisations. The scheme of the Irish Ordnance Survey was undoubtedly too ambitious for the limitations of public finance, and we now possess adequate unofficial descriptions, from the Victorian county histories down to the compact and clever Cambridge geographies, of the greater part of England. The Lichfield country is fully treated in this memoir from a geological point of view, in continuation of the important modern descriptions of the details of our British coalfields; but we should hail some expansion of Mr. G. Barrow's twelve lines on the "distribution of the population." The broad agricultural landscape, controlled by Triassic strata, that is so well seen from the tower of Tamworth, is bounded on the east and west by busy coalfields. The Roman highway leading to the west undulates upwards to the bleak moor of Cannock, a "chase" long after the days when a king's daughter held Tamworth Hill against the Danes. English history is epitomised in the buildings on this hill, now so well preserved as the municipal museum; and the changes in the density of population, from the making of the Watling Street down to the development of the coal-mines, are largely concerned with geology, and deserve a chapter to themselves.

BOTH botanists and geologists will welcome the second part of the memoir on the remarkable petrified plants from the silicified peat-bed in the Old Red Sandstone of Rhynie, Aberdeenshire, by Dr. R. Kidston and Prof. W. H. Lang, just published in the Transactions of the Royal Society of Edinburgh (vol. lii., No. 24, with 10 plates). The genus Rhynia and a new allied genus Hornea are described in detail and referred to a new family, Rhyniaceæ, of the class Psilophytales. These, and the other vascular Cryptogams preserved with them, are the most ancient plants of which the internal structure and external appearance are adequately known. Rhynia and Hornea have neither leaves nor roots, each consisting merely of an underground rhizome, with long, unicellular rhizoids, and a round aerial stem, dichotomously branched, with sporangia at the ends. They are the simplest known undoubted Pteridophyta, and fundamentally more primitive, not only than all existing land-plants, but also than most of the plants of the Upper Devonian and Carboniferous floras. Their geological age is not later than that of the Middle Old Red Sandstone of Scotland, and an apparently related genus, Sporogonites, occurs in the Lower Devonian of Norway. Several interesting comparisons are made with existing Cryptogams, but the authors wisely defer general conclusions until they have studied more of the associated plants.

THE Report of the Department of Mines of the State of Mysore for the year 1917–18 gives a detailed account of the results of the year's mining operations. Naturally, gold-mining in the Kolar goldfield still forms the preponderating part of the industry; it is satisfactory to find that, in spite of the shortage of skilled labour and the difficulty of obtaining supplies owing to war conditions, there was but little falling-off in the output, the production, amounting to 536,558·72 oz. of fine gold, being only 17,689·71 oz. below that of the previous year. The number of accidents shows an appreciable diminution, and it is interesting to note that the dangerous effects of the rock-bursts, to which this field is liable, have been somewhat prevented by the new methods of supporting the hanging wall by means of packs of waste rock. Of the other minerals produced manganese-ore is the most important; the output of this was 31,331 tons as against 20,674 tons in the previous year. Chrome-ore, magnesite, and asbestos are also produced in small quantities, whilst workings for mica, antimony-ore, corundum, galena, and kaolin are proceeding on what can, for the present, be described as a purely experimental scale.

AMONGST the reports on the mineral resources of the United States recently issued by the Geological Survey of that country one of the most interesting deals with the cement production in 1917. It is there pointed out that the United States produced 93,000,000 barrels in that year, as against a production in Europe of 72,000,000 barrels. An interesting account is also given of the development of concrete shipbuilding. The pioneer concrete ship was a small boat built in France in 1849, followed in 1887 by a small vessel built in Holland. In America the first serious attempt was commenced about 1912, when a number of concrete barges were constructed, until in 1918 the *Faith*, a sea-going vessel of 5000 tons, was launched at San Francisco. It is stated that the percentage of dead-weight to full-load displacement for vessels of 3500-tons dead-weight capacity works out at 52 for concrete, 53 for wood, and 68·6 for steel, so that the capacity of the concrete ship is considerably less than that of the steel ship, although this drawback is to some extent offset by the lower first cost of the concrete ship. Much attention is being paid to this problem in the United States, the design of the steel reinforcement and the production of cement of low specific gravity being in particular closely studied. The report, though brief, contains much information of value to those interested in this modern application of reinforced concrete.

THE annual volume of the Journal of the Scottish Meteorological Society recently published contains papers of considerable interest which should be read by meteorologists on both sides of the Tweed. In the first article Lt.-Col. Gold discusses the relation of meteorology to aviation, and directs attention to the new calls which flying has made on the meteorologist. Thus, for example, visibility and cloud-height, to which little attention was directed in the daily weather service a few years ago, are now of great importance, and provision must be made for such observations in any modern system of reporting to a central office. In another paper Dr. E. M. Wedderburn, who did much to advance the usefulness of meteorology to gunners during the war, states the nature of some of the problems met with in this branch of the subject and of the solutions adopted. In the old days gunners were content to use surface meteorological conditions only in working out their corrections. The introduction of the "ballistic wind" and "ballistic temperature," which take account of the changes of the meteorological elements at all heights traversed by the shell, marks a great step forward. A note by Capt. C. K. M. Douglas shows what valuable information concerning the formation of haloes and similar manifestations may be obtained by flying among the clouds which give rise to the phenomena; while an article by Capt. T. B. Franklin on meteorology and agriculture will appeal to a different class of reader.

THE February issue of *Conquest*, the new popular science monthly, gives, amongst other articles of interest, a *résumé* of the first two of Prof. W. H. Bragg's Royal Institution lectures to children on sound and an article by Dr. Rosenhain on glass. In the latter, which is well illustrated, it is pointed out how serious the consequences of our former neglect of the scientific side of glass-making might have been if we had not set about repairing this fault in the early years of the war. The author describes some of the difficulties which have to be overcome before glass suitable for scientific instruments can be produced. Impurities from the melting-pots and enclosed air-bubbles account chiefly for the large percentage of rejected glass, which may reach 80 per cent. Before the war glass

for chemical laboratory use was entirely imported. Our own glass manufacturers have risen to the occasion, and it is to be desired that they should in the future be able to retain a position in the industry.

IT has been known for many years that by treating a photographic plate with a weak solution of a soluble iodide development may be accelerated. In the January issue of the Journal of the Royal Photographic Society S. E. Sheppard and G. Meyer (of the Eastman Kodak Co.) describe some results of their investigations of this action. It seems that the iodide has little or no effect on the action of developers that produce a visible result very soon after their application, but that developers like glycin and hydroquinone, which are slow to produce a visible effect, are much accelerated by it in the early stages of development. With hydroquinone the whole course of development is changed. Ferrous oxalate is not affected by it. The authors suggest that the process of development takes place by the formation of a complex of silver haloid and developer (which then breaks up into metallic silver and oxidation products of the developer), and that the small proportion of silver iodide produced facilitates the formation of this complex. It is well established that silver iodide has a far stronger mordanting action on dyes than silver bromide. Unfortunately for the practical application of the process, the iodide treatment seems always to produce fog.

THE Journal of the British Science Guild for January contains an appeal to members to co-operate more fully in the work of the journal, which is extending its scope. A feature of interest in the present issue of the journal is the series of short editorial notes on topical events, forming a useful supplement to the more detailed accounts of reports, etc., following. A short account is given of the last British Scientific Products Exhibition, and Sir Richard Gregory's address on "Science in Industry," delivered before the Circle of Scientific, Technical, and Trade Journalists at its meeting on the opening day of the exhibition, is reproduced. The report of the Microscope Committee, originally published in the Journal in 1916, is now presented in its revised form. The newly formed Parliamentary Committee, in conjunction with the Agricultural Committee, was instrumental in presenting a memorandum on the Forestry Act, stress being laid on the inclusion, amongst the seven suggested Commissioners, of at least one member having adequate technical and scientific knowledge of the subject. In view of the contemplated legislative measures in regard to deep-sea fisheries, the need for a comprehensive scientific survey of the industry, in order that knowledge may precede legislation, is again pointed out.

THE President of the Board of Education, we note in the Journal of the British Science Guild for January, does not see his way to adopt at once the suggestion of the guild for a consultative committee to advise the Board on matters affecting the relationship of universities and higher technical education to industry, but offers hope that the request may be complied with later. The suggestion conveyed to the Foreign Office that scientific *attachés* should be added to British Embassies and Legations was met by the counter-proposal that technical associations should make their own arrangements to obtain information on foreign developments. The Department of Overseas Trade has issued a circular requesting early intimation of visits to foreign countries by representatives of British firms, in order that consular officers and other officers abroad may be notified. In view of the extensive and valuable work recorded, the appeal being made by the guild for new members and additional funds should meet with generous response. The address of the guild is now 6 John Street, Adelphi, W.C.2.

THE Cammellaird-Fullagar marine oil-engine, constructed by Messrs. Cammell Laird and Co., of Birkenhead, forms the subject of an illustrated article in *Engineering* for January 30. This engine is of the two-cycle type, with two opposed pistons working in the same cylinder, which is open at both ends, and the cycle takes place between the pistons. There are two vertical cylinders in each unit, arranged side by side, and two cranks at 180°. The top piston in each cylinder is connected by inclined rods to the bottom piston of the other cylinder. There are great advantages in this arrangement, among which may be mentioned the saving in space, which is reduced greatly as compared with an ordinary marine four-cycle engine. The opposed piston type has been tried for steam, gas, and petrol engines, and has so far been found wanting. For oil-engines it has several attractive features. There is no cylinder head, and the liner is a single tube free to expand at both ends. Scavenging is simple and effective, since the sweeping-out air enters at the end opposite to that through which the exhaust leaves, and no valves are required to control the scavenging. The piston speed can, in effect, be doubled, due to the compression taking place between the approaching pistons, and thus reducing the most important heat losses during this stroke of the cycle. The turning moment is improved, and stresses are not taken up by the engine framing, but confined to the moving parts of the engine. The test-bed results for the engine under notice are good, and the performances under seagoing conditions will be watched with the greatest interest.

THE latest catalogue (No. 185) of Messrs. W. Heffer and Sons, Ltd., Cambridge, contains the titles of nearly two thousand works, ranging over the subjects of agriculture and husbandry, anthropology and ethnology, botany, chemistry, geology, mineralogy and palæontology, biology, physiology, anatomy and medicine, mathematics and physics, astronomy, and engineering. Some of the volumes were formerly the property of Sir William Crookes and Sir Frank Crisp. In addition to the books referred to, there are for disposal a number of portraits of scientific men.

OUR ASTRONOMICAL COLUMN.

LARGE FIREBALL ON FEBRUARY 4.—In the early evening at 6h. 14m. a splendid meteor was seen from various parts of the country. Among the observers were several persons who have gained experience in recording meteors, so that the real path derived from

their data may be regarded as fairly accurate. The fireball was seen at a low altitude in the southern or south-eastern sky, and it moved very slowly in a very long horizontal flight, distributing sparks as it sailed along, and finally breaking up into fragments.

The radiant was at 145°+8°, and the height of the object from 55 to 44 miles, length of luminous course 275 miles, and velocity 18 miles per second.

The recent fireball was a brilliantly conspicuous object, though the full moon had just risen, and many people mistook it at first for a rocket-like firework on account of its vividness, slow motion, and final burst into spark fragments.

RELATIVE MASSES OF BINARY STARS.—Any increase in our knowledge of the masses of the stars is of great value from a physical point of view, since it throws light on the correlation of mass with spectral type. Mr. G. van Biesbroeck, in *Popular Astronomy* for January, states that photographs of binary stars are now being taken with the Yerkes refractor to determine the motion of each star of the pair, as referred to the background of faint stars, and so obtain the relative masses. Photographs of Castor were taken in the years 1916 to 1919, and give the annual motion of the bright component in R.A. −0·0167s., and for the faint component −0·0118s. Assuming Boss's value for the motion of the centre of gravity, viz. −0·0135s., it results that the faint star is 1·9 times as massive as the bright one. The weakest point is the assumption of the motion of the centre of gravity. Boss assumed equal masses; but since a value identical with his was published in Monthly Notices R.A.S. for 1907 on the assumption that the faint star is six times as massive as the bright one, it would seem that the value −0·0135s. is close to the truth.

The systems of Procyon and ζ Cancri are also being investigated. It is hoped in the former case to fill up the gap in the orbit in the region where the faint star is too near to the primary to observe.

LONG-PERIOD VARIABLES.—Several years ago the Rev. T. E. R. Phillips proposed a division of these variables into Groups I. and II., which differ in the relation to each other of the first and second harmonics, when the magnitude variation is developed in a Fourier's series. Prof. Turner and Miss Blagg contributed a paper to the Monthly Notices R.A.S. for November on the star W Cygni, analysis of the light-curve of which suggested that this star is in the act of passing from Group II. to Group I. A further paper by Prof. Turner was read at the January meeting of the Royal Astronomical Society, in which he examined the observations of several stars of Group II., for which Prof. Chandler gave a secular change of period. The analysis indicates in every case a diminution of period, but seems to show that this takes place by sudden jumps, not by a steady, continuous process, such as Chandler's formula implies. It is suggested that the period decreases to a minimum value, after which the star passes into Group I., and its period then increases again.

It was formerly the idea that these red variables were near the end of their career as suns, but from a study of their proper motions, which seem to be very small, it is inferred that they are giants, near the commencement of their career. From the case of our sun, which is an incipient dwarf star, with a sun-spot variation period much longer than that of any known variable, we may conjecture that after passing into Group I. the period continually lengthens, while the amplitude diminishes and becomes practically inappreciable, except in the case of the sun, the surface of which can be studied in detail.

AUSTRALIAN SIGNPOSTS.

IN the Records of the South Australian Museum for August, 1919,[1] Mr. E. R. Waite completes a description of the Toas or direction signs of the Australian aborigines which was partly translated and arranged from the manuscript of the late Rev. J. G. Reuther, of the Lutheran Mission, by the late Sir Edward Stirling.

The description is prefaced by a summary account of the religious beliefs of the Diari and associated tribes in the district east of Lake Eyre, in South Australia. According to Mr. Reuther, these believed in a single Supreme Being called *Mura*, who was great, powerful, beautiful, omnipresent, righteous, and omniscient. *Mura* created a number of demi-gods—*Muramura*—some perfect and others imperfect, with their wives or subjects—*Mili*. The *Muramura* were the ancestors of mankind. They wandered about the country, and the legends of the natives are the records of their journeys and adventures. Native songs and invocations were addressed to them. The *Muramura* named all things, and many of the natural features of the country are ascribed to them. They named each of their camps from something noticed there, and these are the native place-names of the district.

On the death of a *Muramura* his body usually changed to a stone, which was venerated by his descendants. Sun, moon, and the constellations were also regarded as abodes of departed *Muramura*.

The Toas are thus described. They consist mostly of a piece of flattened wood (usually from 6 in. to 18 in. in length), "pointed at one end, and either coloured or plastered over with white clay, which itself may be coloured uniformly or marked with simple designs. At the upper end the clay is frequently moulded into a spherical or oval knob, and this also may be plain or variously coloured or have inserted some object typical of the locality or symbolical of a Muramura's adventure, such as a tuft of grass, twigs, feathers, hair, etc., pieces of bone, charcoal, or a model of some weapon or utensil. In a considerable number of Toas the upper end is modelled into a representation of some part of the human body, such as the hand, head, or foot, or into that of the whole or some part of a bird, fish, or other animal."

More than three hundred coloured illustrations of Toas contained in the museum collection are given. They show a surprising variety of form and ornamentation. Each Toa has a name which is a native place-name with the suffix *-ni* or *-ri*, meaning "direction towards." Four of the figures, with their explanations, are here given as examples. They are Nos. 1, 14, 66, and 187.

"1. *Dakarawitjarini* (Diari Tribe).—The word means a hard flat or plain, where Emus run to and fro, and it originates from the legend of the Muramura, Ngurakarlina, who, coming to the place, saw many of these birds running about.

"The longitudinal, vertical, and partly sinuous black stripe on the Toa represents a salt creek, the oval patch being a deep waterhole, and the lateral branches tributary creeks. Surrounding these is the plain where the Emus used to run, the white spots indicating bushes and scrub. This is the largest Toa in the collection, being over five feet in length."

"14. *Mararuni* (Wonkanguru Tribe).—To the hand

1 "Description of Toas, or Australian Aboriginal Direction Signs." Being an Abstract from the J. G. Reuther Manuscript by the late Sir Edward Stirling, F.R.S., Hon. Curator in Ethnology, and Edgar R. Waite, Director, South Australian Museum. Pp. 105-55+plates xi-xx Public Library, Museum, and Art Gallery of South Australia. Records of the South Australian Museum. Edited by the Museum Director. Vol. i., No. 2. (Adelaide: Published by the Board of Governors, August 30, 1919.)

with four fingers, the Toa representing a four-fingered hand. The Muramura, Wutjukana, had a servant whose index and middle fingers had partly grown together, as indicated by the Toa. The Toa also has a geographical significance, for when Wutjukana came to a gorge which divided into four branches, one being deeper than the others, he said to himself, 'This place looks like the hand of the servant,' and so he gave it this name."

"66. *Witjikurawinpani* (Tirari Tribe).—To the tracks of the whirlwind in the sand. When the Muramura, Patjalina, once came, hunting, to this place, he noticed that a whirlwind had passed over it, which had effaced the tracks of animals and had swept together a litter of leaves and grass; hence he named

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

it thus. The white knob represents a sandhill overgrown with bushes (red dots) which adjoins Cooper's Creek. The crescent-shaped, black figure below indicates the creek itself, and the black vertical band a deep waterhole at the foot of the hill, which has been washed out by a flood. The surrounding borders of white and yellow signify soil of these colours, and the white spots trees."

"187. *Muramurawintini* (Tirari Tribe).—To the Muramura's hair. So named because on this plain the Muramura, Patjalina, tore out his hair and threw it away. The white colour represents the plain, with watercourses (red and yellow stripes), and, in accordance with the name, the Toa bears a tuft of hair."

When a native is about to remove to another camp he makes a Toa representing the locality to which he is removing and sticks its pointed end into the earth of the camp which he is leaving. Signs are made on the ground directing attention to its presence. His friends who arrive later recognise the significance of the Toa, and are thus made aware of the place to which he has gone.

The whole collection and its elucidation form a most interesting contribution to the study of Australian symbolism.

SIDNEY H. RAY.

HUMAN METABOLISM.[1]

THE first of the monographs before us deals with the prediction of basal metabolism from a knowledge of individual physical and biological constants. The usual process has been to multiply the subject's surface area, as deduced from the height and weight by du Bois's method, by the average Calorie output per square metre determined from a "standard" series, it being assumed that the metabolism per unit area in adults is approximately constant. The order of the error involved and the improvement effected by Drs. Harris and Benedict's process can be gauged by the following example. In these authors' series of 136 adult males, the mean twenty-four hours' basal output was 1631·7 Calories with a standard deviation of 204·7 Calories; the latter is 12·5 per cent. of the mean. The corresponding mean per square metre of surface was 925·5 Calories with a standard error of 74·5 Calories, about 8 per cent. of the mean.

It follows that if the distribution around the mean be assumed to be normal (actually, using a coarse unit of grouping, we find that the authors' series for women is in good agreement with a normal distribution; the series for men is somewhat less regular, but not a very improbable sample from a normal population), the assignment of 925·5 Calories per square metre as the basal metabolism of an unknown individual is subject to a standard error of ±8 per cent. But if a prediction is based upon a multiple regression equation of the first degree, the other variables used being height, weight, and age, the standard error of the prediction falls from 204·7 Calories to 101·7 Calories, or the *average* percentage is 6·2.

These remarks assume that the correlation is normal correlation. As this may not be the case, and as a complete study of the form of the regression cannot profitably be made without a larger collection of data, the authors have empirically tested the accuracies of the several methods, comparing the predictions based on their equations for samples not utilised in the calculation of the constants with those afforded by the surface rule. In nearly every case the regression equations give results closer to the truth than does the surface rule.

We may illustrate with a couple of examples taken at random from the data. A man aged twenty-nine, weighing 66 kg. and 177 cm. tall, had a basal metabolism of 1695 Calories. The surface rule would assign 1675 Calories, with a standard error of 135; the multiple regression formula gives 1664 Calories, with a standard error of 102. Here both results are good. In another case a man aged forty-three, weighing 58·5 kg. and 181 cm. tall, had a basal meta-

[1] (1) "A Biometric Study of Basal Metabolism in Man." By J. Arthur Harris and Francis G. Benedict. Publication No. 279. Pp. vi+266. (Washington: The Carnegie Institution of Washington, 1919.)

(2) "Human Vitality and Efficiency under Prolonged Restricted Diet." By Francis G. Benedict, Walter R. Miles, Paul Roth, and H. Monmouth Smith. Publication No. 280. Pp. xi+701. (Washington: The Carnegie Institution of Washington, 1919.)

bolism of 1331 Calories. The regression formula gives 1486 Calories ± 102; the surface rule 1620 Calories ± 130. Neither prediction is close to the truth, but that of the regression equation is decidedly superior. On the whole, there is no doubt that the regression method is preferable, and that the tables provided by the authors are of value. In general, however, the difference is not such as to give rise to any apprehensions that the use heretofore made of the surface rule has led to practical inconvenience. Prof. Lusk recently wrote:—"For the study of metabolism processes it is certainly most fortunate that the unit of surface area eliminates the same amount of heat in the normal adult within 10 per cent. of a determined average. The reason is not clear."

This remark is not invalidated by Drs. Benedict and Harris's results, although they have provided a somewhat superior criterion. It is proper to notice this point, as our authors are a little too prone to lecture their physiological colleagues upon the real meaning of scientific "laws," and, as we think, exaggerate the importance which the surface "law" assumes in the minds of those who have employed it as a convenient working rule.

Space would have been saved and the statistical results and methods might have been brought to a sharper focus had a number of sententious generalities been omitted. An instance occurs on p. 148. The authors properly remark that surface must be less variable than mass (when Meeh's formula is used), and imply that it is a direct arithmetical consequence that heat per surface unit is less variable than heat per mass unit. This really needed further investigation. The coefficient of variation of an index is a function not only of the coefficients of variation of its constituents, but also of their correlation; the substitution for one constituent of another less variable constituent might not reduce the variability of the index were the correlation also greatly reduced. In the present case the two correlations are nearly equal, and the authors could have actually made their point more securely had they explained the theory of the matter more fully.

Were physiologists really so ill-acquainted with statistical methods as the authors hint, the remarks on p. 16 with respect to the "probable error" of the mean of a sample of four might be dangerous. But we think that British physiologists are quite alive to the importance of biometric methods, sufficiently so to congratulate Drs. Benedict and Harris upon the conclusion of a laborious task which has yielded results of appreciable value to other students of metabolism.

The second volume describes two series of experiments upon squads of college students, originally twelve in each squad. In squad A, diet providing approximately 2500 Calories and 13 grams of nitrogen was maintained for four months; in squad B, a still lower diet, yielding about 9 grams of nitrogen and 1500 Calories, was used for three weeks. The former squad lost on the average 12 per cent. of the initial body-weight, and the basal metabolism per square metre per twenty-four hours fell from 940 to 817 Calories. Squad B lost 6·5 per cent. of the average body-weight, and the basal metabolism also declined considerably. The urinary excretion of nitrogen in both series was not so variable as might have been expected, and did not decline, *pari passu*, with the diminished intake. By the end of the experiment on squad A, an average loss of 175 grams of nitrogen (based on nine men continuously observed) was inferred.

In the course of the experiments intervals of uncontrolled feeding occurred, viz. during the Thanksgiving celebrations, November 29 to December 2, 1917, and during the Christmas holidays, December 20, 1917, to January 6, 1918. On alternate Sundays the diet was usually uncontrolled. A very large number of anthropometric, physiological, and psychological measurements were made upon these men. In addition to the decline of basal metabolism above noted, both pulse-rate and blood-pressure diminished. Little objective evidence of a decrease of physical efficiency was obtained. The majority of the psychological tests pointed to a diminution of efficiency, or at least to a lack of improvement with practice. The students' college work, on the other hand, did not appear to suffer.

The value of this research, which verifies upon a relatively large scale the practicability of diminishing both the rate of metabolism and the quota of body nitrogen by a simple reduction of intake, should be appreciated by scientific clinicians, while many issues of physiological interest are raised and lines of advance suggested to the pure physiologist, especially in connection with the study of levels of nitrogenous metabolism.

As a contribution to the science and art of national dietetics, this elaborate—one might almost say over-elaborate—study is not of so much importance. It is shown that a great reduction, both of available energy and protein, may be borne for some months by healthy adults without either immediate breakdown or sign of enduring deterioration; these are facts which involuntary experiment on a vast scale had already demonstrated. The correlation between variations of nutrition and of resistance to infection, which "common sense" has postulated and which the vital statistics of Europe seem to substantiate, must engage the attention of future investigators; at present an adequate experimental technique is lacking. We do not think that Dr. Benedict and his associates have obtained any results either invalidating the general conclusions expressed by the Food (War) Committee of the Royal Society or filling up lacunæ in our knowledge of the general subject shown by that committee to exist. The experimental and statistical study of national dietetics is still in its infancy. M. G.

ISOSTATIC COMPENSATION IN THE EARTH'S CRUST.

TWO articles on isostasy by the late Prof. Joseph Barrell, which appeared in the *American Journal of Science* for October, 1919, contain what may be regarded as his mature views on the subject. The first, entitled "The Nature and Bearings of Isostasy," was a summary of six lectures delivered by Prof. Barrell at Columbia University in 1916; it gives a general account of the theory of isostatic compensation, and of the methods of investigation which have led to the recognition of the phenomenon. The second article, "The Status of the Theory of Isostasy," was written just before the author's death; it vindicates the theory as to attacks which have been made on it by MacMillan and others, and describes the various views which are held as to the degree of perfection of isostatic balance existing in Nature. Hayford's general conclusion is maintained: that surface inequalities of contour and mass are accompanied by inverse inequalities of density beneath the surface, so that at a depth of about 120 km. equal areas have equal masses superposed; but a view different from Hayford's is taken as to the exactness of this compensation.

Hayford estimated the greatest departure from compensation as being 250 ft. above or below the level for perfect balance over an area of one square degree on

the earth. Other geodesists consider that the deviation is much less than this, even when the areal extent is smaller; Sir S. G. Burrard, for instance, at the recent discussion on isostasy before the Royal Astronomical Society (*Observatory*, December, 1919), suggested that so small a body as the Great Pyramid might be compensated. Prof. Barrell, on the other hand, while admitting that the larger relief of the earth is compensated for with considerable exactness, contends that over limited areas there are large deviations—amounting to 1000 ft. over an area 200 miles in diameter (about 3°), or even more. He regards the upper part of the earth's crust as sufficiently strong to sustain uncompensated loads of this amount, the vertical magnitude of the departure being, of course, inversely proportional to its areal extent; it can thus support individual mountains or limited ranges, as well as erosion features of considerable magnitude, such as the Nile and Niger deltas. Under greater and more widely extended loads, however, the crust is supposed to bend in gentle curves involving but little crustal stress; this bending is accompanied by yielding in a lower, weaker layer, which brings about isostatic compensation.

The question at issue is largely one of fact, which can be settled by observation; *e.g.* if pendulum observations show that the Nile deposits are compensated in the crust, the result will confirm the views of the extreme isostasists, that continuous adjustment goes on when the surface load changes over a comparatively small area. The manner of this adjustment, however, has not yet been made clear, and Prof. Barrell's picture of the process is more easy to conceive. On the other hand, Sir S. G. Burrard has shown recently that the alluvium in the Gangetic trough at the foot of the Himalayas is compensated for. It is much to be regretted that Prof. Barrell's death deprives us of his interpretation of this result.

DEFENSIVE SCIENCE IN GAS WARFARE.

THE prizes and certificates gained by students at the Sir John Cass Technical Institute, Aldgate, were distributed by Lt.-Col. P. S. Lelean, professor of hygiene, Royal Army Medical College, on the evening of Tuesday, February 3, when the chair was taken by the Rev. J. F. Marr, who has succeeded Sir Thomas Elliott, K.C.B., as chairman of the governing body.

Following the distribution, Col. Lelean gave an address on "Defensive Science in Gas Warfare," in which he described the preventive measures that had been adopted to meet its onset and evolution. After referring to the initial attack on April 23, 1915, when the civilised world was aroused to just anger by the news that the Germans had broken their pledged word in respect to the use of poisons as a means of injuring the enemy, Col. Lelean dealt with the means of protection first adopted in the form of pads soaked in sodium thiosulphate, of which no fewer than 98,000 were distributed to the Front within sixty hours of the attack, 300,000 within a week, and 2,000,000 within a month—a truly notable achievement, which was rendered possible only by the combined efforts of men of science, manufacturers, and voluntary helpers.

With the recognition of gas attacks as an established adjunct of modern warfare, this temporary device was succeeded by the more efficient protective appliances which were called for by the advent of toxic, paralysing, and lachrymatory gases such as carbonyl chloride, hydrocyanic acid, and chloropicrin, which culminated first in the adoption of the "P" helmet, of which nearly 27,000,000 were issued between July, 1915, and the final withdrawal in February, 1918, in favour of the now well-known "box-respirator."

A full description was given of the great difficulties that were met with stage by stage during the development of these protective appliances, especially in respect to the need for the complete absorption of the small percentages of the poison gases concerned, together with the fundamental requirements of comparative ease of breathing and exhalation.

Col. Lelean paid a special tribute to the outstanding services of Sir William Horrocks and to the late Col. E. F. Harrison in this connection; also to the many scientific helpers with whom they were associated, and particularly to the gallantry and devotion to duty of the small band of scientific workers who had served under him and upon whom had devolved the practical testing of the efficiency of the many devices which were experimented with in a "lethal chamber" before their issue to the fighting forces could be justified.

In speaking of the helpful war-work contributed by the staff of the Sir John Cass Technical Institute, Col. Lelean expressed the view that it was to such institutes that the nation looked in its hour of scientific need, and had not looked in vain; and that it is to such institutes also that, with an ever-increasing appeal, we shall have to look for victory in the future strife of industrial competition, which can be won only by superior technical skill.

VISUAL TESTS FOR MOTOR-DRIVERS.

THE Council of British Ophthalmologists, realising the importance of submitting chauffeurs and other drivers of motor vehicles to some visual tests, appointed a committee to consider the question. Its report is divided into five parts:—(1) The existing conditions under which licences are at present granted; (2) the number of accidents occasioned annually in London by mechanically propelled vehicles; (3) the various kinds of visual defects in motor-drivers from which accidents may arise; (4) proposed scheme of visual testing for licences; and (5) summary of recommendations. The subject is complicated by the following facts. There are two licensing authorities, the county or borough councils and the police authorities. The requirements vary according to the type of vehicle, *e.g.* private cars, commercial cars, omnibuses, taxi-cabs, and tramcars. The total number of applicants for licences makes it impracticable to submit every one to a satisfactory sight test. The council's chief recommendations are:—

"That special sight-test certificates for drivers of motor vehicles be instituted, and granted to applicants whose sight has been tested by ophthalmic surgeons appointed for the purpose, these certificates to be of three grades: Grade A, certifying the holder's visual capacity to drive any kind of motor vehicle; Grade B, certifying the holder's visual capacity to drive any kind of motor vehicle other than a motor-omnibus or tramcar; and Grade C, certifying the holder's visual capacity to drive a motor-tramcar.

"*For Grade A Certificate.*—(1) Every applicant, in addition to manifesting his ability to steer a motor-car satisfactorily in daylight, should be required, in a trial trip at night, to show himself capable of driving in dim light and under varying degrees of illumination. (2) In an examination by an ophthalmic surgeon he should show: (*a*) Visual acuity of 6/9 in one eye and 6/24 in the other eye without the aid of glasses; (*b*) a full field of vision in each eye; (*c*) no manifest squint; and (*d*) no double vision.

"*For Grade B Certificate.*—(1) Every applicant, in addition to manifesting his ability to steer a motor-car

satisfactorily in daylight, should be required, in a trial trip at night, to show himself capable of driving in dim light and under varying degrees of illumination. (2) In an examination by an ophthalmic surgeon he should show: (*a*) Visual acuity of 6/9 in one eye and 6/24 in the other eye, with glasses if necessary; (*b*) a full field of vision in each eye; and (*c*) no double vision.

"*For Grade C Certificate.*—(1) Every applicant should be required in a trial trip to show himself capable of driving a motor-tramcar by day and by night under varying degrees of illumination. (2) In an examination by an ophthalmic surgeon he should reach the same visual standards as for a Grade A certificate."

The council has clearly taken great pains to consider the subject in all its manifold bearings. The recommendations appear to be adequate and reasonable, and there is evidence that the authorities are favourably disposed to them.

INERTNESS OF INDUSTRIAL EXPLOSIVES.

FROM Western Australia we have received an interesting report on investigations into the development of inertness in industrial explosives of the nitro-compound class by Mr. E. A. Mann, Chief Inspector of Explosives, and his colleague, Mr. T. N. Kirton (Perth, W.A.: Government Printers). These investigations were started in 1912 in consequence of repeated complaints from the mines that the explosives supplied failed to do the work expected of them. That these complaints were not without foundation was soon ascertained by obtaining samples of the explosive under suspicion and testing their velocities of detonation. The method employed was the well-known D'Autriche system, by which the velocity is calculated in relation to the meeting point of detonations of "cordeau détonant" or T.N.T. fuse initiated at either end by detonators embedded at a fixed distance from one another in the sample under test. The results were startling, and in some instances almost incredible had they not been confirmed by excellent photographs. One of the most striking cases is perhaps that of a gelignite cartridge both ends of which were shattered by the detonators attached to the T.N.T. fuse, while the main body of the cartridge remained intact. This is, of course, an extreme case, but in several instances the velocity of detonation was found to be as low as a few hundred m.p.s. as compared with about 2300 m.p.s. on arrival in the country. Another significant feature is that these inert samples have invariably increased in density from about 1·60 on arrival to about 1·69.

Although a certain degree of after-gelatinisation, with consequent reduction of sensitiveness to detonation, is a recognised phenomenon even in this country, it has not been sufficient to have any practical effect in our temperate climate; but as a result of this report it cannot be denied that, so far as our Oversea Possessions are concerned, the matter is of considerable importance, and deserves the consideration which we understand our leading manufacturers are giving to it. From concurrent observations which the writers of the report have made in regard to the alteration in the viscosity of the nitro-cotton when extracted with amyl acetate, they are disposed to attribute the phenomenon to a change in the molecular structure of this ingredient, and the further investigations they promise will be interesting.

FLOW OF WATER THROUGH A PIPE.

A PAPER entitled "The Orifice as a Means of Measuring the Flow of Water through a Pipe" describes experiments made by Messrs. Davis and Jordan, of the Engineering Experiment Station of the University of Illinois (Bulletin 109), to determine the practicability of measuring the flow of water in a pipe line by means of the pressure drop across a circular orifice in a thin plate diaphragm inserted at a pipe joint. The experiments, which covered a range of pipe diameters ranging from 4 in. to 12 in., show that as a temporary measuring device, or where the loss of head produced by the diaphragm is not serious, the method is capable of useful application. Measuring the upstream head at a point 0·8 of the pipe diameter from the diaphragm, and the downstream head at a point 0·4 pipe diameter from the diaphragm, the discharge is proportional to the square root of the difference of these heads. For a given pipe, the discharge coefficient varies slightly with the diameter of the orifice and with the velocity of flow. So long as the ratio of the diameters is between 2 and 8, the variation is, however, small. For measurements in which an error of 2 per cent. is not serious, the discharge may be taken as given by:—

$$Q = AK\sqrt{h} \text{ cub. ft. per sec.}$$

where A is the area of the pipe in sq. ft.

" h is the difference of head on the two sides of the orifice.

" $$K = \sqrt{\frac{2g}{2.64\left(\frac{D}{d}\right)^4 - 1}}.$$

Tables showing the accurate values of K for different diameters of pipe and of orifice are given in the original paper. The device would appear to be of value for field service, as being capable of easy and inexpensive application, since in a flanged pipe system the diaphragm may be inserted at a joint with little or no disturbance of the existing piping.

APPLICATIONS OF AMPLIFYING ELECTRIC VALVES.

M. L. BLOCH communicates an interesting paper on the industrial applications of the amplifying valves used in radio communication to the *Revue Scientifique* of January 10. When the vacuum is almost perfect these valves can be used to increase the amplitudes of high-frequency oscillations at least a thousandfold. Their great advantage is that they act as if devoid of inertia, and so completely solve the problem of a telephonic relay. They are already in use in long-distance telephony. For alternating currents of low frequency the vacuum in the valves does not need to be nearly so high. If argon is used a vacuum of 3 cm. suffices, and currents as large as five amperes can pass through the valve. The valves can be usefully employed for charging accumulators from alternating-current circuits. Another important application is for measuring very small currents and pressures. The currents are magnified a thousand times, and then they actuate direct-reading instruments. By their use the messages sent from the powerful American radio stations at Annapolis and New Brunswick can be recorded on a Morse ribbon in Paris. They were much used in "earth-telegraphy" during the war. Two conductors were fixed in the ground about 50 metres apart, and a source of high-frequency current and a microphone were connected between the conductors. The receiving circuit was

similar, but contained an amplifying valve and a telephone. Messages could easily be sent in this way. This method proved of great value when the ordinary lines were cut by the enemy. The valves also made "direction finding" and communication between aeroplanes easy. When used as generators they give currents the frequencies of which can be varied from a tenth to millions per second. They are of great value, therefore, for calibrating wave-meters. It is also possible by their use to maintain the oscillations of mechanical vibrators by suitable arrangements. They introduce the equivalent of negative friction or negative damping into the circuits.

THE FUTURE OF TROPICAL AUSTRALIA.

THE possibilities of settlement in tropical Australia are discussed in great detail by Mr. Griffith Taylor in the *Geographical Review for* August (vol. viii., No. 2). Taking tropical Australia to be bounded by the southern tropic, Mr. Taylor gives it an area equal to barely 40 per cent. of the total area of Australia and about one-thirtieth of the total population. Analysing carefully the climatic and vegetational factors, he concludes that it is mainly a pastoral land except in eastern Queensland, where tropical crops and wheat do well. The coastal lands of the Gulf of Carpentaria are also fit for agriculture. Mr. Taylor sees little hope of tropical Australia becoming a prosperous and productive land if the White Australia policy is maintained. Chinese are chiefly restricted to tropical lands with an abundant rainfall. The hot, dry climate of the greater part of tropical Australia is best suited to the natives of India. Even if white settlement proved to be possible by a slow process of acclimatisation, it would only be at the cost of many lives, and at best would take a very long time. But, assuming that political difficulties will eventually be overcome, Mr. Taylor tries to estimate the future population that tropical Australia could support provided transport facilities are introduced. One district in the interior of Western Australia and the Northern Territory, with an area of about 150,000 square miles, is suited for any population. The remainder of the area under consideration, according to his estimate, could support a total population of about 1,400,000, with a density varying from 8 per square mile in the east of Queensland to 1 per square mile or less in the more arid parts of Western Australia and the inland regions of the Northern Territory. Mr. Taylor's paper is a valuable contribution to the study of Australian problems.

PLANT-LICE IN THE TROPICS.

A RECENT publication of the Scientific Institute of Buitenzorg contains a well-worked-out monograph by P. Van der Goot of the aphides of Java. The author attributes the comparative scarcity of plant-lice in the tropics, as compared with temperate regions, to the attacks of insect enemies such as Syrphidæ, Coccinellidæ, and mining wasps, and also to the occurrence of violent rainstorms, drought, and other unfavourable climatic conditions. The tobacco plant and sugar-cane are the only cultivated plants seriously injured by aphides in Java. In Europe there is always a longer or shorter period of lowered temperature during which the functions of plants are more or less in abeyance. This unfavourable period is generally passed through by aphides in the form of eggs laid in autumn by sexually developed females. If, however, the temperature is artificially kept up, the sexually developed females persist, together with the eggs, and propagation takes place in the regular manner, *i.e.* by means of parthenogenetic, viviparous females. In the tropics there is no considerable lowering of temperature; there is, however, generally a rainy and a dry season. In the latter, though there is often a failure of nutriment, there is never found a rest-form in the condition of sexually produced eggs. Even in mountain regions, where in the dry season the temperature may fall to freezing point, the author has never found sexually developed aphides. Propagation of these insects in the tropics, says Van der Goot, takes place invariably by means of parthenogenesis. He has never observed in Java a regular migration of aphides; whether such a phenomenon ever occurs he is unable to conjecture The production of winged forms does not always depend on the drying-up of plant-food, for some species acquire wings in the middle, and others at the end, of the dry season.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The board of management of the Brewing School has given the sum of 20,000*l.* for the endowment of a chair of brewing, to be known as the Adrian Brown chair, in memory of the late Prof. Adrian Brown, F.R.S., the first professor of brewing in the University.

A sum of more than 2000*l.* has been subscribed for the endowment of a lectureship in social philosophy as a permanent memorial in honour of Prof. J. H. Muirhead.

LIVERPOOL.—The council of the University has appointed Mr. G. E. Scholes to the recently established chair of engineering-thermodynamics of heat engines. Mr. Scholes studied in the engineering department of Owens College, Manchester, and has held important teaching posts in engineering subjects at Manchester and Liverpool Universities and in the Army engineering schools. During his career in the Army, which he joined in 1915, Mr. Scholes did valuable work as a captain-instructor in petrol and other engines at one of the R.E. schools. Also as experimental officer he successfully devised important technical improvements relating to aircraft defence. The chief of these was a device in connection with sound-locators, which Mr. Scholes designed and constructed. This invention was adopted and standardised, the inventor being awarded a grant from the Inventions Award Committee.

MANCHESTER.—Mr. Frank Watts, who has been appointed assistant to the director of the Department of Industrial Administration at the College of Technology, will devote especial attention to a study of vocational selection and training, and assist in working out a set of tests of industrial fatigue.

THE Regional Association, the president of which is Prof. Patrick Geddes, will hold a conference on regional survey during the Easter vacation (April 6–13) at the Outlook Tower, Edinburgh. Residence is being arranged in University Hall, so that the advantages of communal life may be enjoyed during the week.

THE Seale-Hayne Agricultural College at Newton Abbot, in Devon, commenced last month its first series of regular courses in agriculture with a very satisfactory complement of students. The courses given comprise a three-year diploma in agriculture, a two-year certificate in agriculture and horticulture, and short courses upon various subjects of agricultural importance, such as poultry-keeping, dairying, etc.

THE election to the Sorby research fellowship of the Royal Society and the University of Sheffield will

take place after Easter. The appointment will be for five years, and the value of the fellowship is approximately 500*l.* per annum. The person elected will be expected to pursue his investigations at the University of Sheffield, if possible. A copy of the regulations governing the fellowship is obtainable from the Royal Society, the secretaries of which will receive applications for the fellowship itself up to April 20.

A COURSE of five public lectures is to be given at 5 o'clock on successive Wednesdays, beginning on February 25, at the Imperial College of Science and Technology, South Kensington, by Sir Richard Glazebrook, the University of London Zaharoff professor of aviation. The subjects will be:—"Aeronautical Research," "Stability and its Investigation," "Instruments and Methods of Full Scale Research," "Strength of Construction," and "The Airscrew: Its Design and Efficiency." Application for tickets of admission should be made to the Registrar of the college.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 29.—Sir J. J. Thomson, president, in the chair.—Prof. W. **Bateson** and Caroline **Pellew**: The genetics of "rogues" among culinary peas (*Pisum sativum*). In a previous communication (Proc. R.S., lxxxix., 1915) the authors showed that certain intermediates between types and rogues in peas had a peculiar genetic behaviour. Families raised by self-fertilisation from them consist of a small minority of type-like plants and a majority of rogues. Preliminary experiment showed that the type-like plants come from seeds contained in the *lower* pods. Investigations of the past four years, consisting chiefly of reciprocal crosses made from successive flowers, have confirmed this conclusion, and proved further that the ratio of type-like to rogue-like gametes is different on the female and male sides. On the female side the ratio is about equal for the first ten flowers, after which the proportion of rogues increases. On the male side, taking the type-like gametes as unity, the proportion of rogue-like for the first six flowers in succession is as follows:—4·6, 4·9, 7, 10, 12·3, and 29·5. From self-fertilisations the proportion found for the first six flowers is 15, 11, 13, 15, 54, and more than 100. There is thus a gradational change in successive flowers. This gradual elision of the type-characters must be brought about by a process similar to that which operates more rapidly in the case of F, plants bred between type and rogue. These, though containing the type, breed rogues only, the type being excluded in the base of the plant.—L. T. **Hogben**: Studies of synapsis. I.: Oogenesis in the Hymenoptera. The more salient conclusions arrived at are as follows:—(1) Sex determination in ♀ agamically produced: In Cynips and Rhodites (agamic forms) there is reduction of the chromosomes in the young oocyte. The somatic number of chromosomes in Rhodites is 18, as believed by Henking. The chromosomes of the young oocyte counted by Schleip are double (bivalent). Henking's belief in the doubling of chromosomes in segmentation is confirmed. Both polar bodies are probably formed as the result of homotypic division. (2) The maturation prophases: A diploteric and pachyteric stage with the bicipoid number of filaments follows synapsis in all cases in the young oocyte. At this stage nurse-cells are differentiated. In Cynips, Rhodites, and Orthopelma the *diploid* number reappears after a "diffuse" stage. These univalents pair end to end, as described by Heynes in Copidosoma. There are thus two chromosome conjugations in the parasitic Hymenoptera, as described in Lepidosiren by Agar, but not hitherto confirmed in other animals by other work. An abortive spindle followed by an atypical formation of polar bodies appears to be general in the Hymenoptera. (3) Secondary nuclei and the oosoma: Secondary nuclei were observed in the oogenesis of Synergus, Formica, and Lasius. They appear to arise from chromidia ejected from the germinal vesicle at the time when the latter undergoes diminished staining capacity. The "oosoma" arises in Synergus as a cloud of cytoplasmic granules. It is not nuclear in origin.—H. **Onslow**: A periodic structure in many insect scales, and the cause of their iridescent colours. The cause of iridescence in insects, etc., still remains unexplained. The minute structure of many iridescent bodies was investigated, because the most eminent physical authorities differed fundamentally as to the cause of their colour. The great variety of structures described and illustrated shows that each object must be judged on its own merits, because no general theory will explain all cases. The principal type of colour-producing structure found in butterflies has not hitherto been described. It consists of transparent plates of chitin separated by films of air. These plates are at right angles to the scale-surface, and only a few half-wave-lengths in thickness. Their height, shape, and colour together control the colour-tone and saturation. Some butterflies have plates of chitin apparently parallel to the plane of the wing; others, again, show structures the colour of which cannot be explained. Reasons are given showing that the monochromatic transmission and reflection colours in beetles' scales are probably not entirely due to "gratings," as was proposed by Michelson. The chief objections to metallic reflection in the case of scales are not met with in the wings of scaleless beetles. Here the colour-producing layer is so near the surface that it would be difficult for any other adequate structure to exist. In certain beetles the colour is produced by a thick layer of doubly refractive rods, such that sections tangential to the surface still retain their colour. The wing chitin of golden "tortoise beetles" appears metallic at all depths when moistened, but loses colour when dry. In other insects and some ticks the colour returns on wetting, apparently because there is a thin film, which by adsorbing water becomes transparent, and can cause interference. Iridescence in dragon-flies, the eyes of flies, plants, and certain hairs, such as the golden mole, is also discussed.

Mineralogical Society, January 20.—Dr. A. E. H. Tutton, past president, in the chair.—Dr. E. S. **Simpson**: Gearksutite at Gingin, Western Australia. This mineral, which occurs in Cretaceous greensand, is considered to have a composition corresponding to the formula $CaF_2.AlF(OH)_2.H_2O$, and to have originated from the interaction *in situ* of fluorapatite, gibbsite, and carbonated water.—C. E. **Barrs**: Fibroferrite from Cyprus. Analysis of material from Skouriotissa, Cyprus, gave the following result. Fe_2O_3, 31·36; SO_3, 30·95; H_2O (by difference), 37·01; insoluble, 0·68.—Dr. G. T. **Prior**: The classification of meteorites. For purposes of the classification of meteorites, the significance is pointed out of the chemical composition of the nickel-iron and the magnesium silicates. In the case of meteoric irons, the structural features, as revealed by etching, are shown to be closely related to the content of nickel. In meteoric stones the proportion of magnesia to ferrous oxide in the magnesium silicates varies directly with the proportion of iron to nickel in the nickel-iron. On these principles the four classes of meteorites, viz. irons, stony-irons, chondrites, and achondrites, can be divided into interrelated groups.

The three groups of chondrites are distinguished as enstatite-chondrites, bronzite-chondrites, and hypersthene-chondrites, according to the chemical composition of the pyroxene. The achondrites are divided into corresponding groups of enstatite-achondrites, bronzite (-augite)-achondrites, and hypersthene-achondrites, while a fourth group is added richer in lime (and mostly also in alumina) than the chondrites. To avoid confusion owing to Brezina's misuse of the term chladnite, the enstatite-achondrites, comprising Aubres, Bustee, and Bishopville, are called aubrites; while for the hypersthene-achondrites (Shalka, etc.) a reversion is made to Tschermak's original name of diogenite.—A. F. **Hallimond**: Torbernite. In continuation of the author's previous work, a series of weighings was made on Gunnislake material held over various concentrations of sulphuric acid. Dehydration did not occur at the pressure required, and only took place slowly over strong acid in a period of many months. It is clear that this mineral cannot be identical with ordinary torbernite. The refractive index agrees with that found for an abnormal torbernite by N. L. Bowen. Normal torbernite has the density 3·22 and mean index 1·585, while for artificial metatorbernite and for the Gunnislake mineral the density is 3·68 and the index 1·624. An approximate reading yielded for Gunnislake crystals $c:a=2·28:1$. The basal planes of the two forms are of the same dimension, and the volume-change due to the addition of $4H_2O$ is borne by an increase in the vertical axis. The density of the water of crystallisation is 1·2, a value common in hydrated salts, while the refractive power is equal to that for liquid water.

CAMBRIDGE.

Philosophical Society, January 26.—Sir Joseph **Larmor**: Gravitation and light.—E. **Landau**: Note on Mr. Hardy's extension of a theorem of Mr. Polya.—L. J. **Rogers**: A Gaussian series of six elements.

MANCHESTER.

Literary and Philosophical Society, January 20.—Sir Henry A. Miers, president, in the chair.—Prof. W. M. **Calder**: Geography and history in the Mediterranean. The author described the relation of the Mediterranean to the series of great plains lying to its north and south, and to the mountain systems known as "the roof of the world." The influence of the sea and land routes on the trade and growth of neighbouring countries was discussed. The great importance of Aleppo as the railway junction of the future for London, Berlin, Calcutta, Cairo, and Cape Town was pointed out. "Rail power" may one day restore the Levant to its ancient position as the centre of communications of the Old World.

Literary and Philosophical Society (Chemical Section), January 30.—Mr. R. H. Clayton in the chair.—Dr. R. S. **Willows**: Recent work on colloids. A definite amount of energy is associated with definite colloidal areas. Adsorption was defined and sols described. Surface tension and some technical applications were discussed by the author.

PARIS.

Academy of Sciences, January 5.—M. Henri Deslandres in the chair.—A. **Lacroix**: The systematic classification of grained rocks containing plagioclase and felspars.—C. **Moureu**, C. **Dufraisse**, P. **Robin**, and J. **Pougnet**: The stabilisation of acrolein. Preservative action of phenolic bodies. Phenols all possess the property of stabilising pure acrolein, and certain polyphenols (pyrocatechol, hydroquinone, and pyrogallol) are especially active.—A. **de Gramont**: The direct arc-spectra of metals of low melting point. The metals examined were lead, zinc, cadmium, tin, antimony, bismuth, aluminium, and magnesium. In some cases spectrographs were obtained showing three spectra of the same metal (spark, direct arc, and carbon arc) on the same plate, and reproductions of these for lead and tin are given.—P. **Humbert**: The calculations of G. H. Darwin on the stability of the pyriform figure. G. H. Darwin and Liapounov came to opposite conclusions on the stability of the pyriform figure of equilibrium of a fluid in rotation. The method used by Darwin, due to Poincaré, is exact, but the development of the series was not carried to a sufficient number of terms, and the results are inexact, or at least doubtful.—A. **Véronnet**: The formation of an isolated star in an indefinite homogeneous nebula.—J. **Andrade**: The experimental control of doubly damped pendular vibrations.—G. A. **Hemsalech**: The emission of positive luminous particles by the alkali metals at high temperatures.—A. **de Gramont**: Observation on the preceding communication.—J. B. **Senderens**: The catalytic hydrogenation of lactose. A repetition of the experiments of Ipatiew on the reduction of lactose in water-alcohol solution by hydrogen at high pressures (74 atmospheres) at 130° C. in presence of nickel and nickel oxide. The main product of the reaction is dulcite, but there is a secondary reaction depending on the activity of the nickel catalyst. A new sugar, lactosite, $C_{12}H_{24}O_{11}+H_2O$, is formed, and corresponds to the melibiotite obtained as a syrup by Scheibler and Mittelmeier. On inversion, lactosite gives sorbite and galactose.—E. **de Loisy**: A commercial method for the synthetic production of alcohol or ether, starting with coal-gas. The velocity of absorption of ethylene from coal-gas by sulphuric acid is increased by the addition of a catalyst, and the same acid can be used in succession for the removal of ethylene, other unsaturated hydrocarbons, moisture, and, finally, for the preparation of ammonium sulphate.—N. J. **Lebedeff**: The Carboniferous in the Caucasus chain.—Ch. **Picquenard**: The fossil flora of the coal basins of Quimper and Kergogne.—Ch. **Gorceix**: Some considerations on the surfaces of equal density at the interior of the earth.—E. **Licent**: The ascophore form of *Clasterosporium fungorum*.—G. **Mangenot**: The evolution of the chondriome and plasts in the Fucaceæ.—P. **Noguès**: Hovering flight produced by a horizontal wind of invariable direction and velocity.—MM. **Constantin** and **Soula**: A new method of graphical recording in physiology, using a microphone and electromagnetic style. A directly recording sphygmograph.—Mlle. M. **Gauthier**: The "trypanosome" of the trout. The first trypanosome was discovered by Valentin in 1841 in the blood of a trout, but no further work on this particular parasite appears to have been done since that date. Additional observations on this organism show that it should not be included in the genus Trypanosoma properly so-called, but in the genus Trypanoplasma, created by Laveran and Mesnil in 1901.—T. **Kabéshima**: Experimental therapy on germ-carriers.—F. **d'Herelle**: The process of defence against the intestinal bacilli and the ætiology of diseases of intestinal origin.—P. **Courmont** and A. **Rochaix**: The bacterial flora of sewage effluents purified by the method known as *boues activées*. The reduction in bacteria by this process is considerable, and the species remaining in the effluent are all aerobic, and include no known pathogenic form.—F. **Bordas**: The preparation and conservation of vaccinal pulp. Reply to some criticisms by P. Achalme and Mme. Phisalix.

January 12.—M. Henri Deslandres in the chair.—G. **Bigourdan**: The observatories of Lalande at the

Palais-Royal and at the Collége de France.—L. **Maquenne** and E. **Demoussy**: The distribution and migration of copper in the tissues of green plants. Twenty-seven species of plants were examined, and copper was found in all parts of the plants, this metal tending to accumulate at points where the percentage of water is at a maximum. The increase of copper is not the consequence of a physico-chemical phenomenon, as is the case with silica and calcium carbonate, but follows a process analogous with that governing the nutrition of the plant.—A. **Blondel**: A method for the measurement of atmospheric transparency.—L. **Pomey**: Fermat's numbers.—M. **Pauthenier**: The absolute retardations in Kerr's phenomenon.—P. **Braesco**: The expansion of copper-antimony alloys. There is a sharp maximum in the increase of length for the alloy containing 38·6 per cent. of antimony, a composition corresponding with the compound Cu_3Sb; no indication of the existence of any other definite compound is given by the expansion curves.—N. H. **Dhar** and G. **Urbain**: The polarisation e.m.f. and the constitution of complex cobaltic compounds.—E. **Wourtzel**: The existence of nitrous anhydride in the gaseous state. The contraction produced on mixing known quantities of NO and O_2 was measured, keeping the NO in excess. Two experiments gave a contraction corresponding with the presence of about 2·5 per cent. of N_2O_3 in the gas mixture. This is sufficient to explain the known production of nitrite when the gas is absorbed by alkaline solutions.—A. **Kling**, D. **Florentin**, and E. **Jacob**: The preparation of chlorinated methyl carbonates.—F. **Canac**: Determination of the orientation of the rows and reticular planes of a crystal.—P. **de Souza**: The Lower and Middle Carboniferous in Portugal.—J. **Savornin**: The geology of Djurdjura and Biban (Algeria).—P. **Russo**: The phosphatic Eocene and Turritelles layers of Tadla (Western Morocco).—L. **Besson**: Diminution of the transparency of the air at Paris. Systematic observations from the summit of the Tour Saint-Jacques in the centre of the city, initiated in 1895 by J. Joubert and carried on continuously under identical conditions for twenty-five years, lead to the conclusion that for the first twenty years the clearness of the atmosphere was slowing decreasing; during the period of the war this diminution became much more marked.—G. **André**: The inversion of cane-sugar during the preservation of oranges.—E. **Saillard**: The nitrogen balance in sugar manufacture. Precipitation of the albuminoid materials of the beetroot by sulphurous acid, bisulphites, and hydrosulphites. Sulphurous acid and its compounds precipitate the same polarising materials as basic lead acetate, working with normal beets; they also precipitate the same albuminoid materials from the beet-juice as copper hydrate.—M. **Lemoigne**: A specific reaction of 2 : 3-butyleneglycol and of acetylmethylcarbinol, products of the butyleneglycollic fermentation. As the production of acetylmethylcarbinol serves to differentiate certain closely related groups of micro-organisms, a delicate and specific test is desirable. The culture is oxidised with a little ferric chloride and distilled; diacetyl passes into the distillate. This is treated with ammonia, hydroxylamine chloride, and a nickel salt, when the scarlet nickel dimethylglyoxim is produced. Acetylmethylcarbinol at a dilution of 1 in 1,000,000 can be readily recognised by this test.—W. **Kopaczewski** and Mme. Z. **Gruzewska**: Seric toxicity and the physical properties of colloidal gels. A relation has been established between the toxic power of gels and the sign of their electric charge. Gels with a positive electrical charge (alumina, barium carbonate, ferric arsenate, calcium phosphate, ferric oxide) have no toxic power, but an electro-negative silica gel is toxic.—A. **Krempf**: The development and relations of the orthosept and sterigmatosept in the Anthozoa.—E. **Grynfeltt** and L. **Carrère**: The muscles of the iris of the crocodile.—L. **Chopard**: Observations on the praying mantis and its parasites.—M. **Lagrange**: The compressive and decompressive operation of the eyeball.—M. **Fouassier**: The decomposition of hydrogen peroxide by micro-organisms extracted from pasteurised milk.

BOOKS RECEIVED.

Practical Science for Girls: As Applied to Domestic Subjects. By E. E. Jardine. Pp. xiii+112. (London: Methuen and Co., Ltd.) 3*s*.

A Class-Book of Organic Chemistry. By Prof. J. B. Cohen. Vol. ii. Pp. vii+156. (London: Macmillan and Co., Ltd.) 4*s*. 6*d*.

A Manual of Practical Anatomy. By Prof. T. Walmsley. In 3 parts. Part i.: The Upper and Lower Limbs. Pp. viii+176. (London: Longmans and Co.) 9*s*. net.

Employment Psychology. By Dr. H. C. Link. Pp. xii+440. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

The Birds of the British Isles and their Eggs. By T. A. Coward. First series. Pp. vii+376+159 plates. (London: F. Warne and Co., Ltd.) 12*s*. 6*d*. net.

Mathematics for Engineers. By W. N. Rose. Part ii. Pp. xiv+419. (London: Chapman and Hall, Ltd.) 13*s*. 6*d*. net.

Physiology and National Needs. Edited by Prof. W. D. Halliburton. Pp. vii+162. (London: Constable and Co., Ltd.) 8*s*. 6*d*. net.

Scientific Method: Its Philosophy and its Practice. By F. W. Westaway. New edition. Pp. xxi+426. (London: Blackie and Son, Ltd.) 10*s*. 6*d*. net.

Physiology of Farm Animals. By T. B. Wood and Dr. F. H. A. Marshall. Part i.: General. By Dr. F. H. A. Marshall. Pp. xii+204. (Cambridge: At the University Press.) 16*s*. net.

The Universities and the Training of Teachers. By F. J. R. Hendy. Pp. 28. (Oxford: At the Clarendon Press.) 1*s*. 6*d*. net.

Food Supplies in Peace and War. By Sir R. H. Rew. Pp. vii+183. (London: Longmans and Co.) 6*s*. 6*d*. net.

Telephonic Transmission: Theoretical and Applied. By J. G. Hill. Pp. xvi+398. (London: Longmans and Co.) 21*s*. net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. E. Conrady: Recent Progress in Applied Optics.

ROYAL SOCIETY, at 4.30.—J. W. McBain and C. S. Salmon: Colloidal Electrolytes. Soap Solutions and their Constitution.—C. C. Farr and D. B. Macleod: The Viscosity of Sulphur.—C. V. Raman and B. Banerji: Kaufmann's Theory of the Impact of the Pianoforte Hammer.—Commander T. Y. Baker, R.N., and Prof. L. N. G. Filon: A Theory of the Second Order Longitudinal Spherical Aberration for a Symmetrical Optical System.—Prof. J. W. Nicholson: The Lateral Vibrations of Sharply Pointed Bars.—R. E. Slade: A New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide.—Dr. S. Chapman: A Note on Dr. Chree's Discussion of Two Magnetic Storms (Title only).—Dr. C. Chree: An Explanation of the Criticisms on Dr. Chapman's Recent Paper: "An Outline of a Theory of Magnetic Storms" (Title only).

LONDON MATHEMATICAL SOCIETY (at Burlington House), at 5.—G. S. Le Beau: A Property of Polynomials whose Roots are Real.—The late E. K. Wakeford: Canonical Forms.—E. Landau and A. Ostrowski: A Problem of Diophantine Analysis.—G. H. Hardy and J. E. Littlewood: The Zeros of Riemann's Zeta-function.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. D. P. Sutherland: The Work of a Tuberculosis Department.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. F. G. Thomson, Dr. J. C. McClure, and W. P. Kennedy: Resumed Discussion on The Merits and Defects of the British Health Resorts.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. C. W. Kimmins: The Dreams of Children in Blind, Deaf, and Industrial Schools.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Major K. Edgcumbe: The Protection of Alternating-current Distribution Systems without the Use of Special Conductors.
OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street), at 7.—Dr. R. S. Morrell: Colloid Chemistry of Paints and Varnishes.
OPTICAL SOCIETY, at 7.30.—J. W. French: The Surface Layer of an Optical Polishing Tool.—Mrs. C. H. Griffiths: Aberration Effects in Star Images.—R. W. Cheshire and W. Shackleton: The Testing of Heliograph Mirrors.
INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (at 28 Victoria Street), at 8.—F. R. Cowell: Steering Gears.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. Rows: Anxiety States.
SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY, at 5.—Prof. C. H. Lees: Presidential Address.—Sir Arthur Schuster: Atmospheric Refraction during Total Solar Eclipses.—To be followed by the Annual General Meeting.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery (Hunterian Lecture).
MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.
JUNIOR INSTITUTION OF ENGINEERS (at 39 Victoria Street), at 7.30.—F. E. Henman: Gas Manufacture.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. W. M. Bayliss: The Volume of the Blood and its Significance.

SATURDAY, FEBRUARY 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation. III. Deflection of Light in the Sun's Gravitational Field.

MONDAY, FEBRUARY 16.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery (Hunterian Lecture).
INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—A. B. Eason: Automatic Telephony for Private Branch Exchanges.
ARISTOTELIAN SOCIETY (at 74 Grosvenor Street, W. 1), at 8.—A. F. Shand: Impulse, Emotion, and Instinct.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—P. Waterhouse: Education of the Architect.
ROYAL SOCIETY OF ARTS, at 8.—C. F. Cross: Recent Research in the Cellulose Industry (Cantor Lecture).
SURVEYORS' INSTITUTION, at 8.—Capt. W. H. Tapp: Survey on the Western Front.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H.E. the Spanish Ambassador: The Spanish Zones in Morocco.
MEDICAL SOCIETY OF LONDON, at 9.—Dr. H. R. Spencer: Tumours complicating Pregnancy, Labour, and the Puerperium (Lettsomian Lecture).

TUESDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. Wilson: Magnetic Susceptibility.
ROYAL STATISTICAL SOCIETY, at 5.15.—Prof. E. H. Starling: Food Conditions in Germany during the War.
INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. W. R. Ormandy: Recent Patents on Mixed Fuels.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—N. E. Tuboshes: Fancy Lighting in Portraiture.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—J. Reid Moir: The Occurrence of Flint Implements of Man in the Glacial Chalky Boulder Clay of Suffolk.

WEDNESDAY, FEBRUARY 18.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Lt.-Col. A. H. W. Haywood: The Campaign in the Cameroons.
ROYAL SOCIETY OF ARTS, at 4.30.—S. Preston: English Canals and Inland Waterways.
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. W. G. Spencer: The Historical Relationship between Experiments on Animals and the Development of Surgery (Hunterian Lecture).
ROYAL METEOROLOGICAL SOCIETY, at 5.—Capt. C. J. P. Cave: The Status of a Meteorological Office and its Relation to the State and to the Public.—W. H. Dines: Atmospheric and Terrestrial Radiation.—D. Brunt: Internal Friction in the Atmosphere.
ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. R. C. Buist: The Salernitan Verses and their English Versions.
INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Civil Engineers), at 6.—Major C. E. Prince: Wireless Telephony on Aeroplanes.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Major P. Bishop: Aircraft Design in relation to Standardisation.
ROYAL MICROSCOPICAL SOCIETY, at 8.—Mrs. Agnes Arber: Studies on the Binucleate Phase in the Plant cell.—R. Beer and Mrs. Agnes Arber: Multinucleate Cells: An Historical Study (1879-1919).—C. Akehurst: Exhibition of Prof. Silverman's Illuminator for Opaque Objects.

THURSDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.
ROYAL SOCIETY, at 4.30.—*Probable Papers*: Prof. B. Moore and T. A. Webster: Studies of Photo-synthesis in Fresh-water Algæ.—Prof. W. M. Bayliss: The Properties of Colloidal Systems. IV. Reversible Gelation in Living Protoplasm.—Rev. F. J. Wyeth: The Development of the Auditory Apparatus in *Sphenodon punctatus*.
LINNEAN SOCIETY, at 5.
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—T. B. Stevens and C. E. Blackett: The Use of Haloid Cyanides for the Purpose of Gold Extraction.
CHEMICAL SOCIETY, at 8.—S. B. Schryver and C. C. Wood: A New Method for the Estimation of Methyl Alcohol.—C. S. Gibson and W. J. Pope: β-Dichlorethyl Sulphide.—W. K. Slater and H. Stephen: Some Derivatives of Fisetol.—M. F. Barker: Calorific Value and Constitution. Part I.—J. B. Firth: Surface Tension of Alcohol-Water Mixtures.

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY OF LONDON, at 3.—(Anniversary Meeting.)
ROYAL COLLEGE OF SURGEONS, at 5.—Prof. G. Elliot Smith: The Evolution of the Cerebellum (Arris and Gale Lecture).
INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—E. M. Bergstrom: Recent Advances in the Utilisation of Water Power (Resumed Discussion).
CONCRETE INSTITUTE (at 296 Vauxhall Bridge Road), at 6.—H. K. Dyson: Some Points in Reinforced Concrete Design.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—A. Serner and Others: Discussion on State Ownership *v.* Private Enterprise.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. J. Russell: British Crop Production.

SATURDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.
PHYSIOLOGICAL SOCIETY (at Lister Institute), at 4.

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